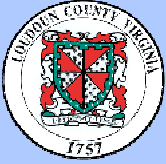


***Progress Update on the
Compilation, Management, and
Analyses of Hydrologic and
Hydrogeologic Data for
Loudoun County, VA***

***Presented to:
Water Resources Technical
Advisory Committee***

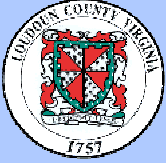
**September 19, 2007
(Updated and redistributed October 31, 2007)**



Review

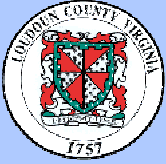
Three general components of the work...

- **Hire FTE for water resource data management**
- **Compile and organize available data**
- **Analyze existing hydrologic and hydrogeologic data**



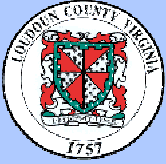
Review

- ✓ **Board approved WRTAC/staff recommendations (12/06)**
- ✓ **Funds transferred to B&D budget (2/07)**
- ✓ **Staff (w/ HR) developed description of water resource data manager position, advertised, and interviewed (2/07 – 5/07)**
 - **Mr. Scott Sandberg hired 6/07**



Review

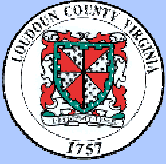
- ✓ **Staff began identifying, compiling, and organizing available data (1/07)**
- ✓ **Staff developed SOW tasks to analyze and evaluate data and reviewed drafts with WRTAC (2/07 – 6/07)**



Update

Entry of data from hydrogeologic studies

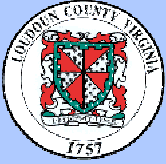
- Contracted with *Emery & Garrett Groundwater, Inc.* and *GeoTrans, Inc.* to provide data in digital format from a combined total of ~148 hydrostudy reports these companies had submitted to the County since the 1980s
- County staff converted ~15 hydrostudy reports (from other contractors) into digital format
- All hydrostudy data added to database (7/07)



Update

Hire independent consultant to analyze and assess hydrologic and hydrogeologic data

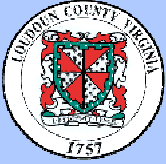
- **Staff worked closely with County Procurement Office**
- **Time issue – RFP process would extend project well into 2008 (beyond WRTAC and BOS terms)**
- **Identified existing WMCOG contract with national engineering / environmental firm (CH2M Hill) that County could “ride” by way of WMCOG agreement**



Update

(Contracting continued)

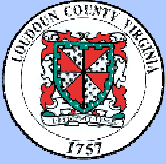
- **Comprehensive Watershed Management Plan project (“CWMP” - funded w/ EPA grant) on approximately parallel track time-wise**
- **CH2M Hill had resources to accomplish both scopes of work and, therefore, the work was combined into 1 contract which was signed in early August**



Update

(Contracting continued)

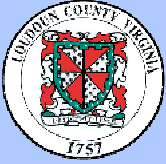
- **Contract deliverables and invoicing divided into “hydrologic assessment” and “watershed management” parts**
- **As part of contract, County staff would compile available data from multiple sources and conduct initial phase of statistical analyses on major data sets**



Update

(Contracting continued)

- **All data and initial analyses by County provided to CH2M Hill for their review in early September**
- **CH2M Hill currently conducting additional analyses and evaluation/assessment of hydrologic and hydrogeologic conditions**

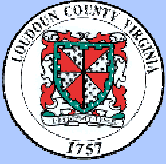


Update

Advantages of this contracting approach:

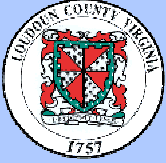
- **Allows for schedule that completes hydrologic assessment before end of 2007 (during BOS and WRTAC terms)**
- **Efficiency of managing 1 contract vs. 2 separate contracts**

and.....



Update

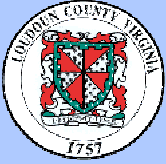
- **Synergy of analyzing and conducting “hydrologic” and “watershed” work in close sequence. Promotes more complete understanding of the water resources system and results in better final products for Loudoun County.**



Summary of Combined Tasks

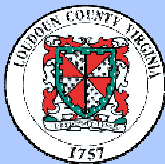
- 1. Compile available data from multiple sources**
- 2. Hydrologic data analyses – (precipitation; stream flow and water quality; wells, groundwater levels, and quality; on-site sewage disposal; baseline and assessment of conditions)**
- 3. Presentations to WRTAC, LWMSSC, and TLUC and report (draft and final)**

Continued...



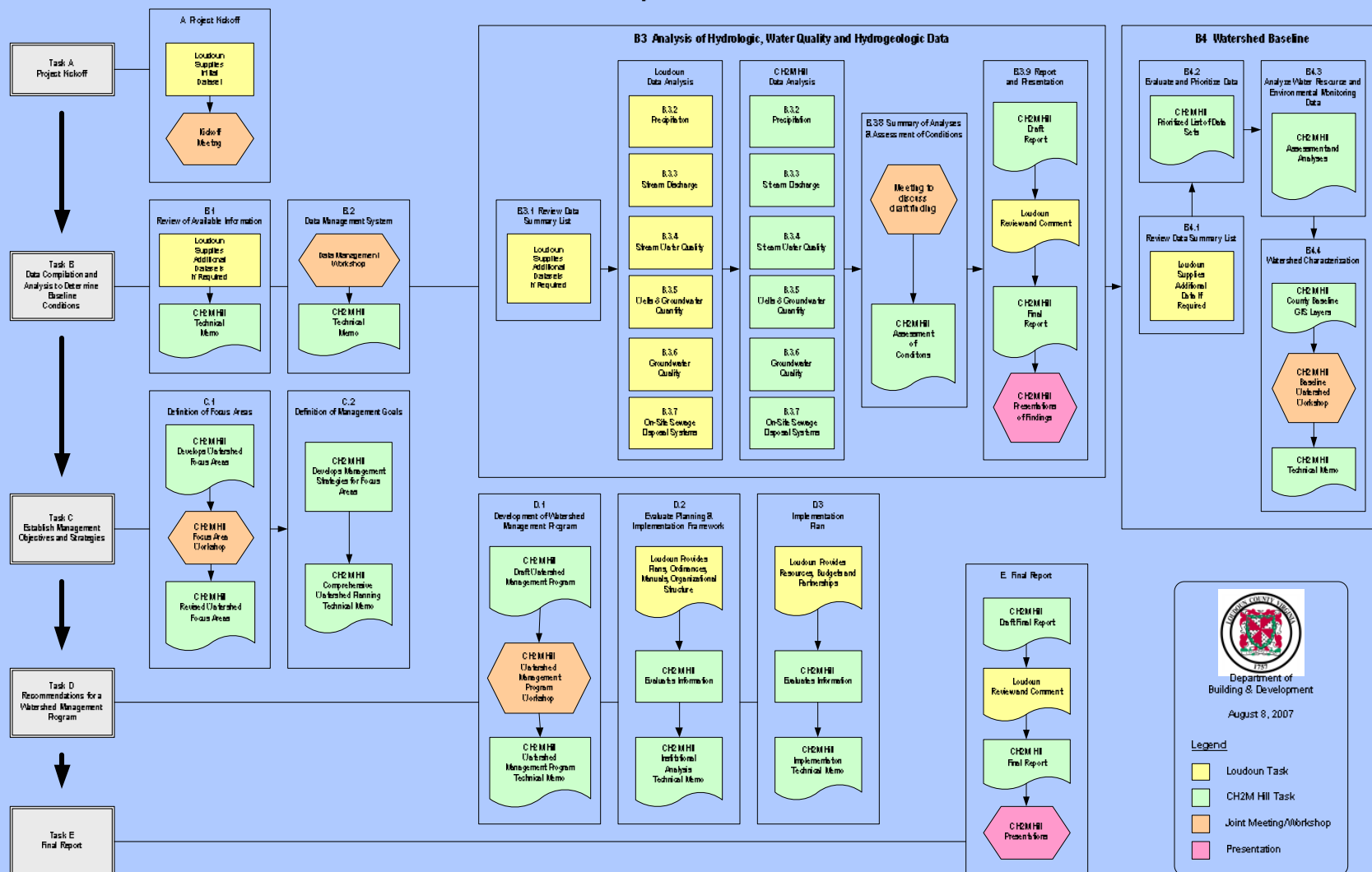
Summary of Combined Tasks

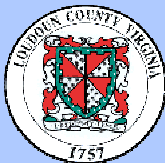
- 4. Characterize watershed conditions and identify focus areas**
- 5. Develop watershed management goals and approaches**
- 6. Evaluate County's planning and implementation framework and develop basic watershed implementation plan**
- 7. Presentations to WRTAC, LWMSSC, and TLUC and report (draft and final)**



Flowchart of Combined Contract Tasks

Comprehensive Watershed Management Plan Project Flowchart





Approximate Schedule

Approximate Schedule of General Project Tasks

General Task	2007												2008			
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
Develop work scope and contracting																
Identify / compile available data									→	→	→	→	→	→	→	→
Enhance data management system													→	→	→	→
Hydrologic data analyses and report											▼					
Characterize watersheds												•				
Develop focus areas / management goals													•			
Develop watershed management program														•		
Evaluate planning / implementation framework																
Develop basic implementation plan																
Final report																▼

→ On-going activity

▼ Report deliverable and presentation

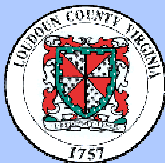
• Workshop



PROVISIONAL RESULTS

- Existing water resource and related data identified from many sources
- Selected data incorporated into water resource data management system
- Organized data sets, queries, and analytical results available for use





Data management

PROVISIONAL RESULTS

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Raw Data
Files

Reformatted
Data Files

Each set of new or updated data
requires reformatting and checking
for completeness and accuracy
before entry into database

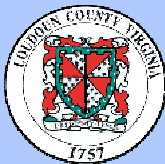
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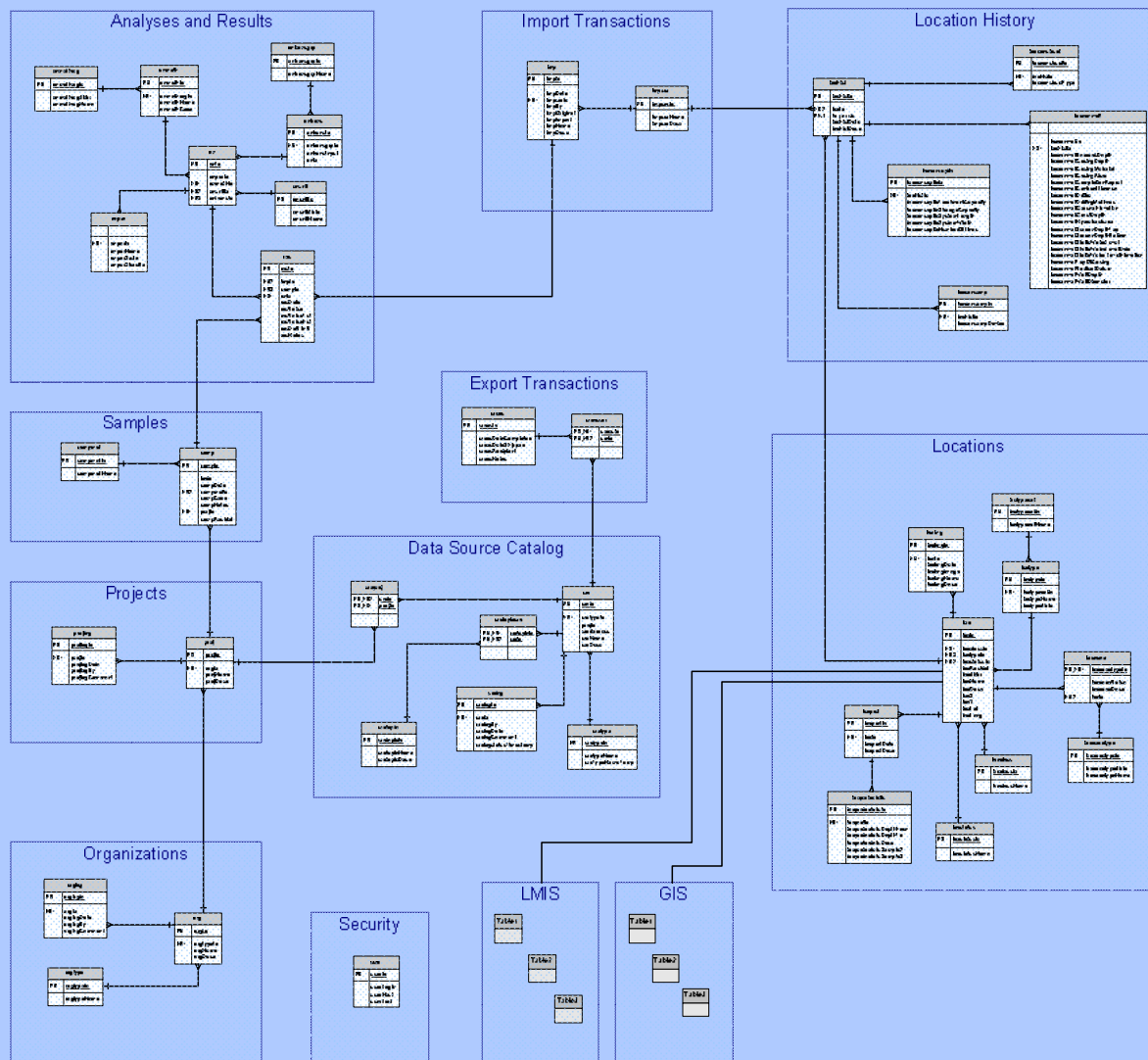
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12903	June 26, 1971	6	0	0		0	0	0.00	0.00	0.00	0.00	0.00	0.00
12904	June 27, 1971	6	0	0		0	0	0.00	0.00	0.00	0.00	0.00	0.00
12905	June 28, 1971	6	0	0		0	0	0.00	0.00	0.00	0.00	0.00	0.00
12906	June 29, 1971	6	0	0		0	0	0.00	0.00	0.00	0.00	0.00	0.00
12907	June 30, 1971	6	1.4	0		0	0	0.35	1.40	0.00	0.35	0.00	0.00
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12912	June 5, 1972	6	0	0.57		0.17	0	0.19	0.00	0.57	0.19	0.17	0.00
12913	June 6, 1972	6	0	0		0	0.03	0.01	0.00	0.00	0.01	0.00	0.03
12914	June 7, 1972	6	0	0.01		0.02	0	0.01	0.00	0.01	0.01	0.02	0.00
12915	June 8, 1972	6	0	0		0	0	0.00	0.00	0.00	0.00	0.00	0.00
12916	June 9, 1972	6	0	0		0	0	0.00	0.00	0.00	0.00	0.00	0.00
12917	June 10, 1972	6	0.21	0		0	0	0.05	0.21	0.00	0.05	0.00	0.00
12918	June 11, 1972	6	0.12	0		0	0	0.03	0.12	0.00	0.03	0.00	0.00
12919	June 12, 1972	6	0.43	0		0	0	0.11	0.43	0.00	0.11	0.00	0.00
12920	June 13, 1972	6	0.05	0		0	0.44	0.12	0.05	0.00	0.12	0.00	0.44
12921	June 14, 1972	6	0	0.34		0.27	0.01	0.16	0.00	0.34	0.16	0.27	0.01
12922	June 15, 1972	6	0	0.04		0.1	0	0.04	0.00	0.04	0.04	0.10	0.00
12923	June 16, 1972	6	0	0.01		0	0.02	0.01	0.00	0.01	0.01	0.00	0.02
12924	June 17, 1972	6	0.18	0.3		0.53	0.37	0.35	0.18	0.30	0.35	0.53	0.37
12925	June 18, 1972	6	0.39	0.05		0.29	0.11	0.21	0.39	0.05	0.21	0.29	0.11
12926	June 19, 1972	6	0	0.12		0.21	0	0.08	0.00	0.12	0.08	0.21	0.00
12927	June 20, 1972	6	1.1	0.01		0	0.55	0.42	1.10	0.01	0.42	0.00	0.55
12928	June 21, 1972	6	8.26	0.59		0.4	10.67	4.98	8.26	0.59	4.98	0.40	10.67
12929	June 22, 1972	6	1.28	7.67		10.48	1.96	5.35	1.28	7.67	5.35	10.48	1.96

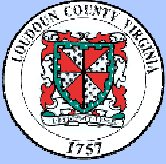


Data Management

Loudoun County Water Resources Data Model

PROVISIONAL
RESULTS

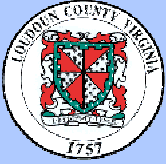




Initial Data Analyses

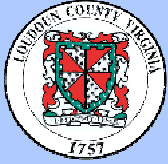
Types of Data Analyzed

- **Precipitation**
- **Streams – stage/discharge and water quality**
- **Groundwater – wells, quantity, and quality**
- **On-site sewage disposal systems**
- *Other data for overall assessment of conditions*



Examples of Initial Data Analyses

**All example results are preliminary
and subject to revision**



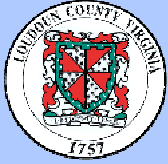
Precipitation

National Climatic Data Center

- **Five stations: Mt. Weather (1948+), Lincoln (1930+), Sterling RCS (1977+), Dulles Airport (1963+), and The Plains in Fauquier County (1954+)**

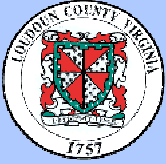
US Geological Survey

- **Two real-time stations: Lovettsville & Limestone Branch (both 2002+)**



Precipitation

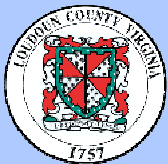




Precipitation

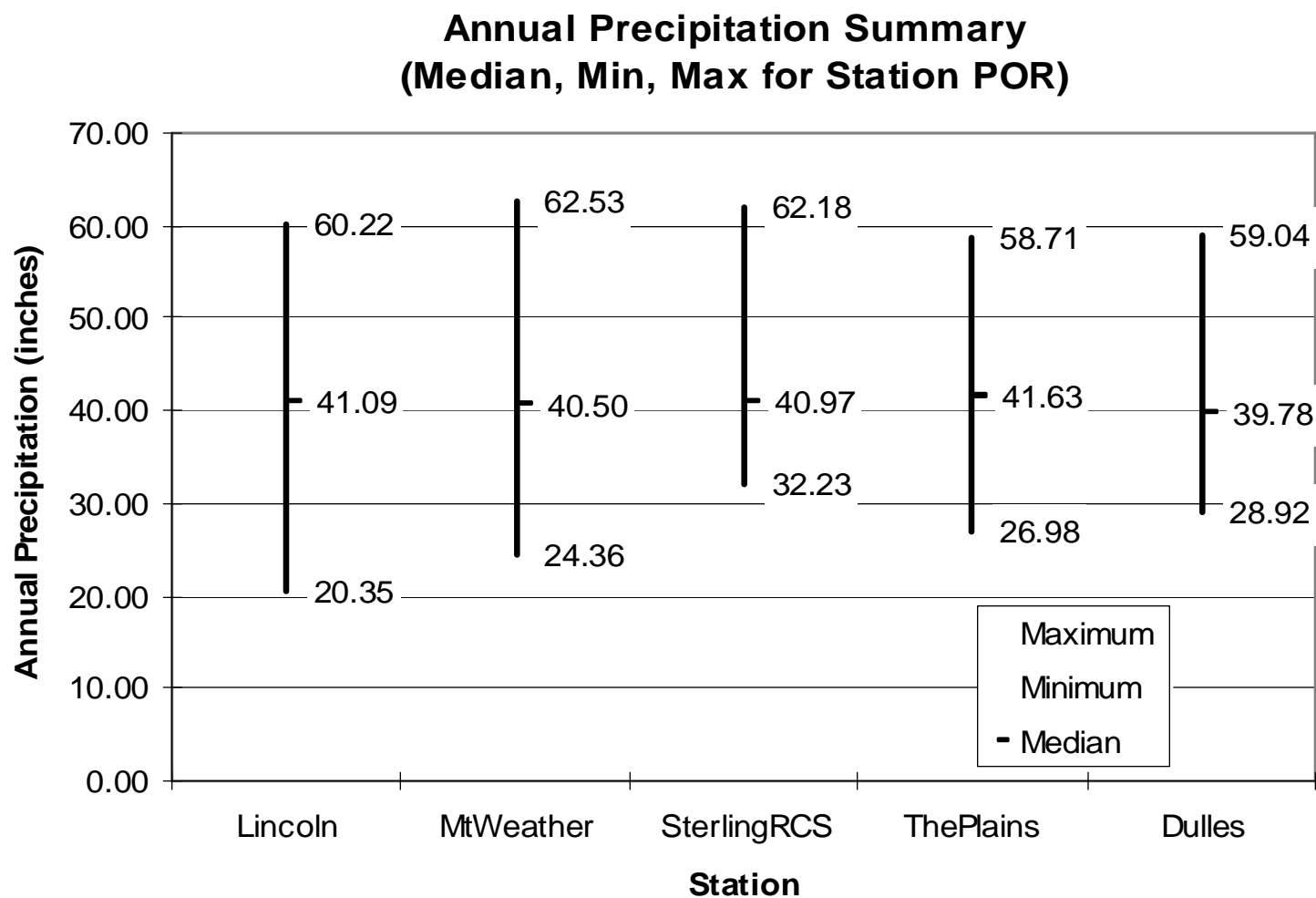
**PROVISIONAL
RESULTS**

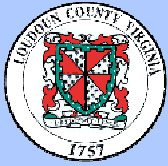
	Lincoln	Mt Weather	Sterling	ThePlains	Dulles
Total # days reported in POR	27,577	20,852	10,468	18,564	14,214
# Days with zero precipitation	20,770	14,663	7,032	12,909	9,708
# Days with precipitation	6,807	6,189	3,436	5,655	4,506
% Days with zero precipitation	75.3%	70.3%	67.2%	69.5%	68.3%
% Days with precipitation	24.7%	29.7%	32.8%	30.5%	31.7%



Precipitation

PROVISIONAL
RESULTS

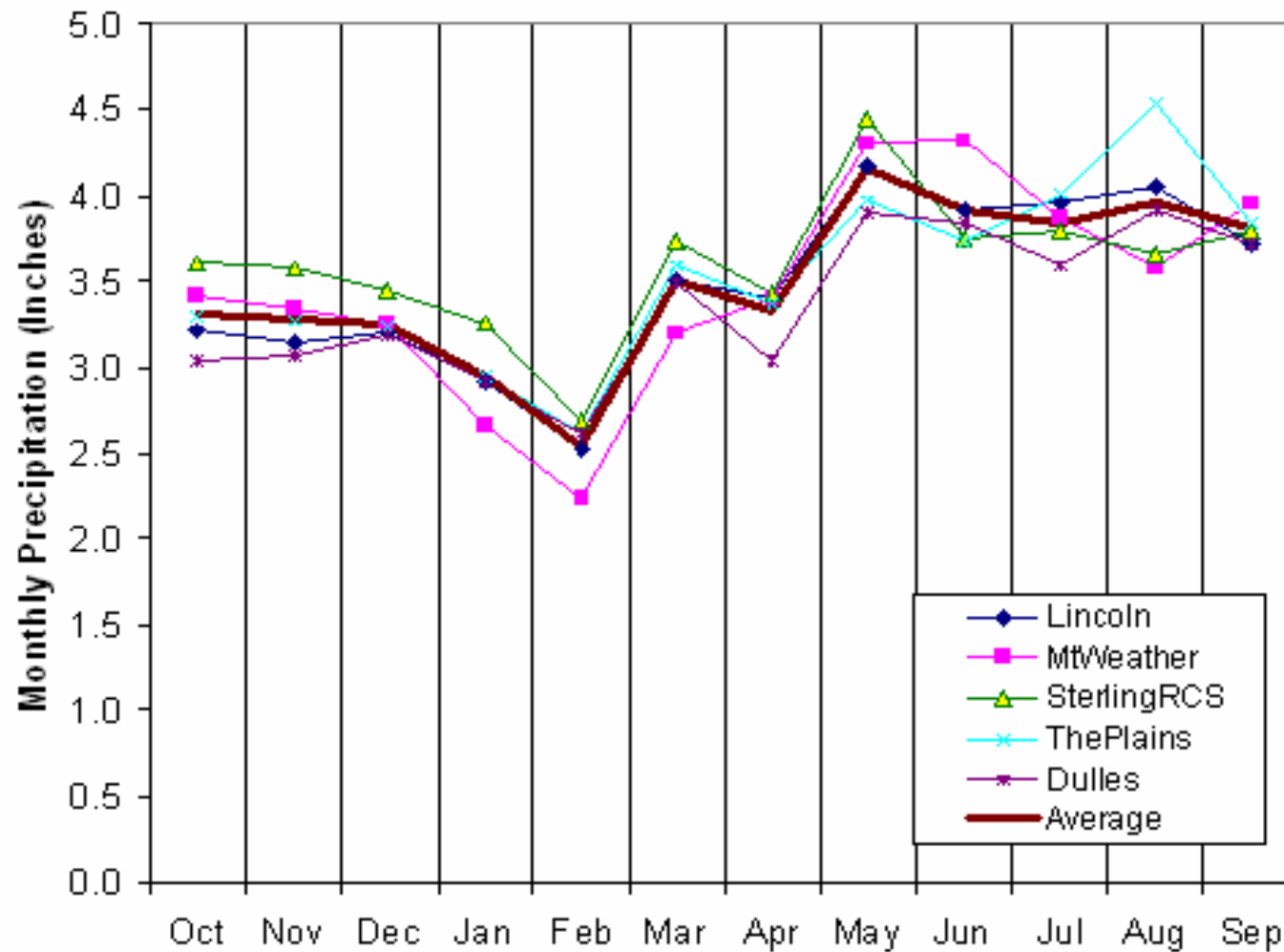




Precipitation

PROVISIONAL
RESULTS

Average Monthly Precipitation for Station POR

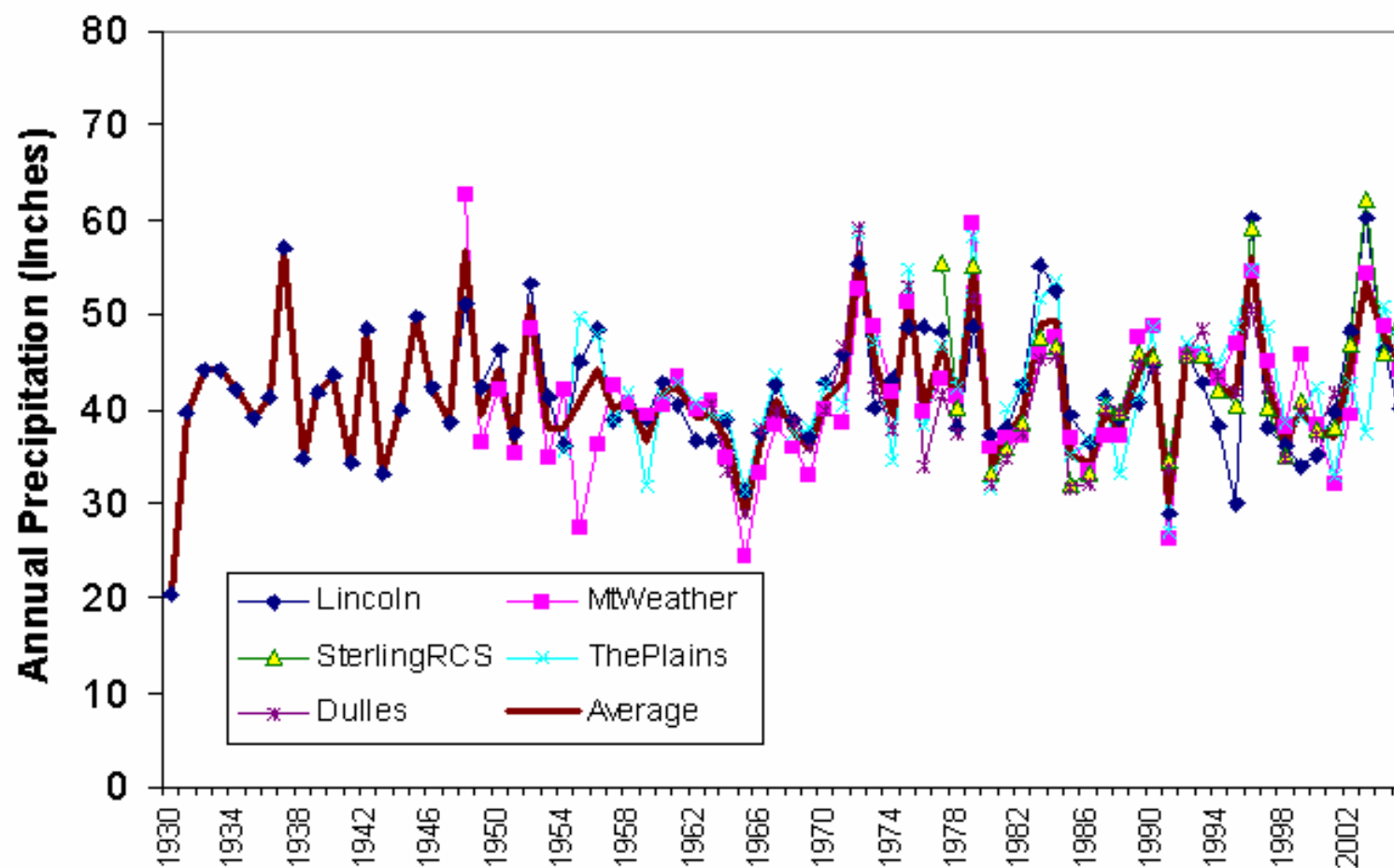


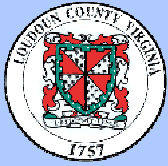


Precipitation

PROVISIONAL
RESULTS

Annual Precipitation for Station POR

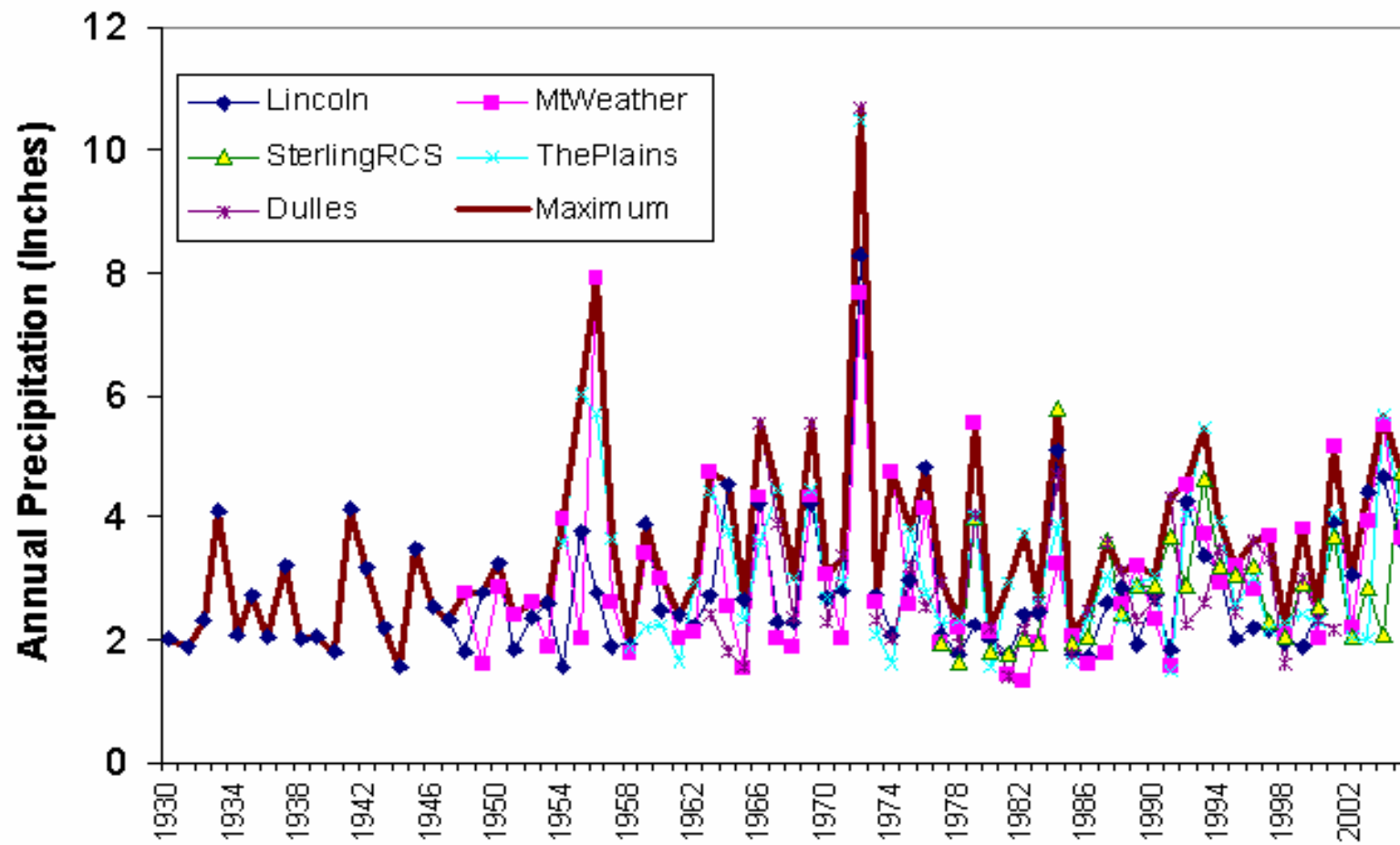


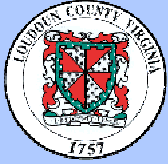


Precipitation

PROVISIONAL
RESULTS

Maximum Daily Precipitation for Station POR





Precipitation

**PROVISIONAL
RESULTS**

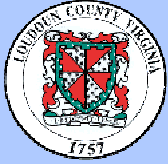
Daily Precipitation Totals (inches) by Year

Entire Period of Record

	Lincoln	MtWeather	SterlingRCS	ThePlains	Dulles
Median	40.88	40.50	40.97	41.63	39.78
Max	60.22	62.53	62.18	58.71	59.04
Min	20.35	24.36	32.23	26.98	28.92
Std Dev	6.95	7.46	7.71	7.08	6.44
Skewness	0.30	0.42	0.77	0.33	0.67

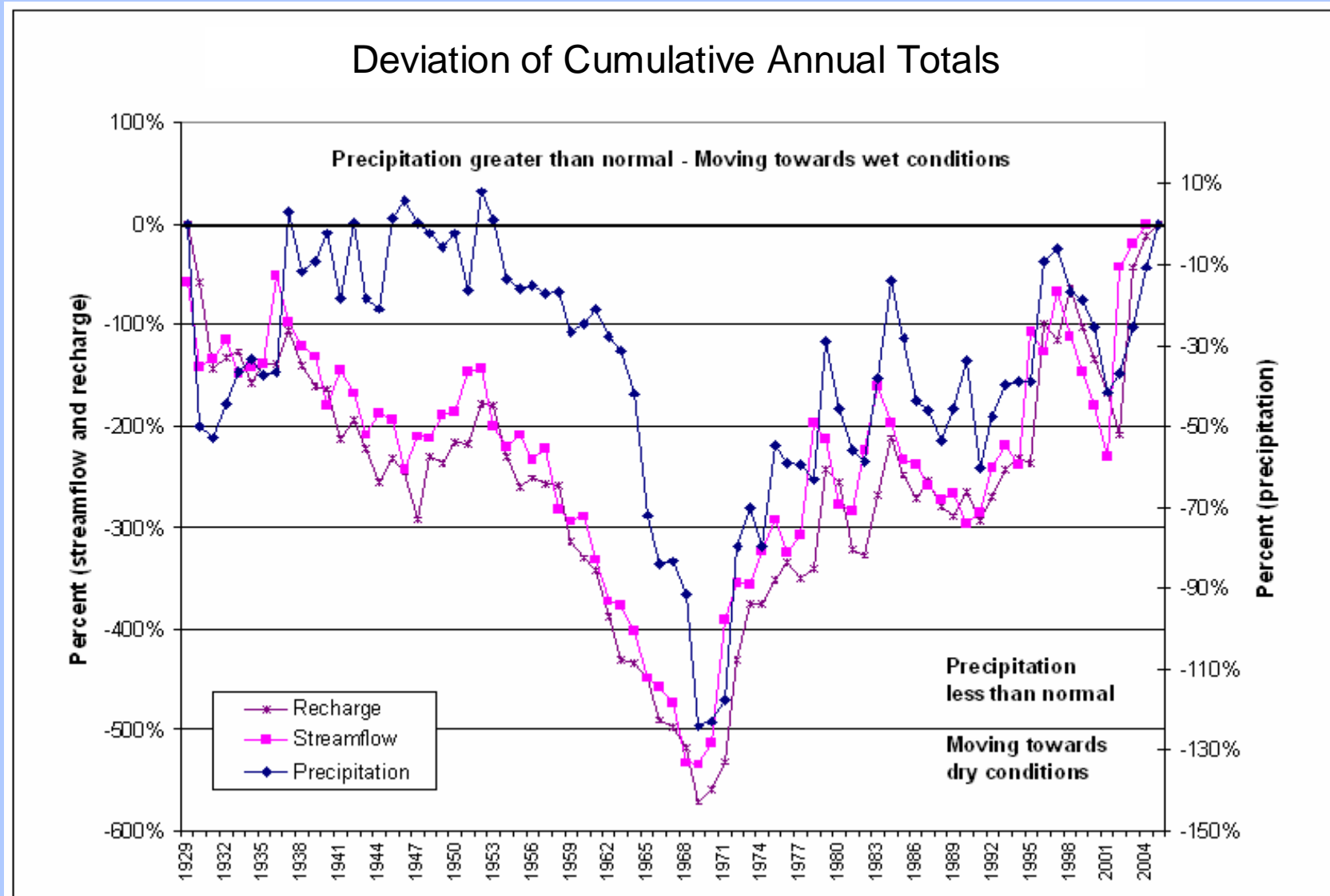
Selected Common Period 1977-2001

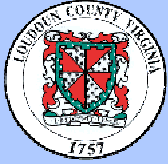
	Lincoln	MtWeather	SterlingRCS	ThePlains	Dulles
Median	39.43	43.01	40.47	42.22	41.37
Max	60.22	59.70	59.04	58.42	51.68
Min	28.86	26.16	32.23	26.98	31.51
Std Dev	7.39	7.29	7.09	7.75	5.68
Skewness	0.84	0.24	0.85	-0.02	0.09



Precipitation

PROVISIONAL
RESULTS

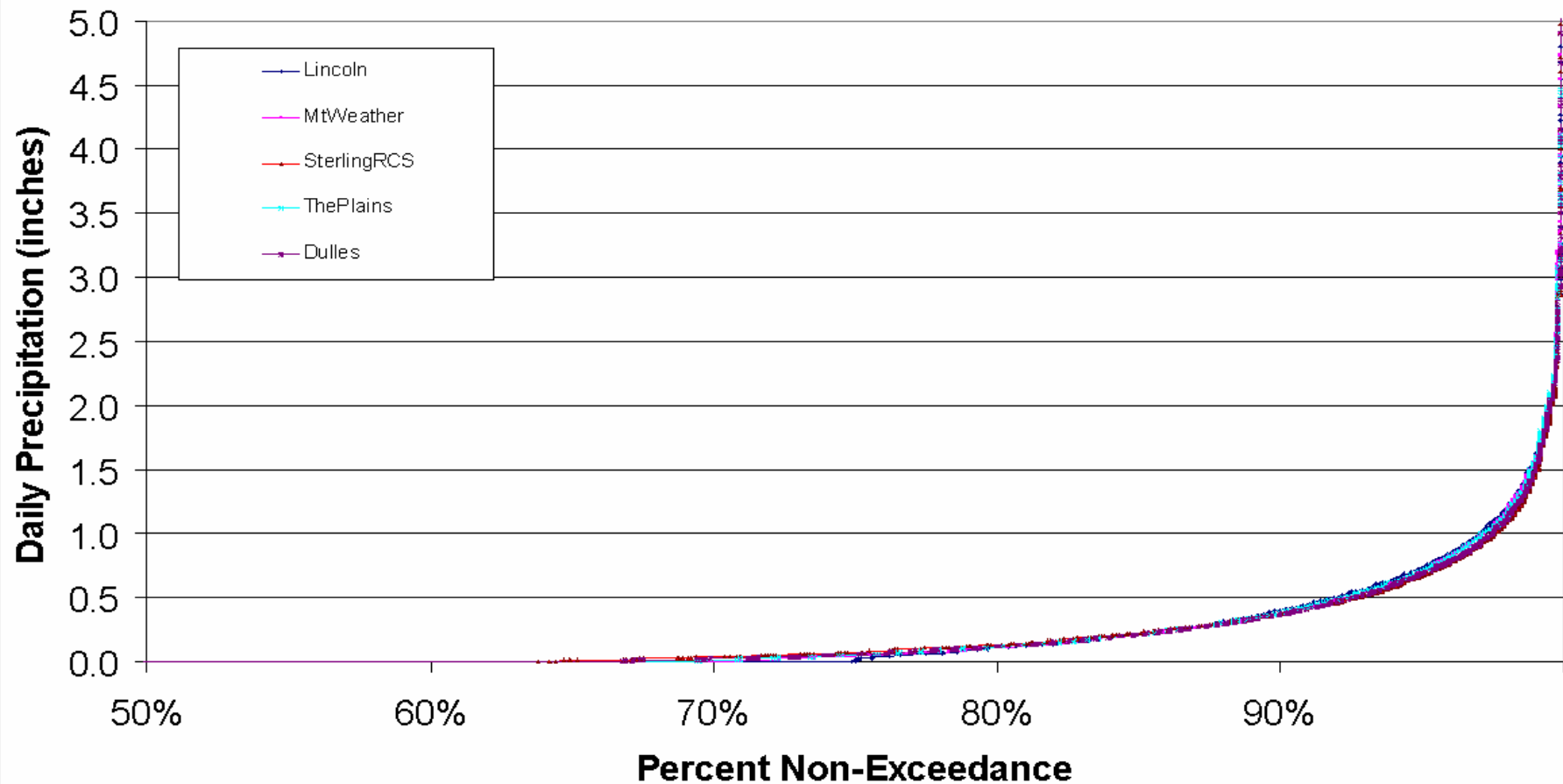


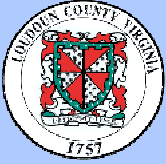


Precipitation

PROVISIONAL
RESULTS

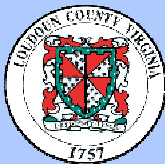
Precipitation Exceedance using Daily Data By Station



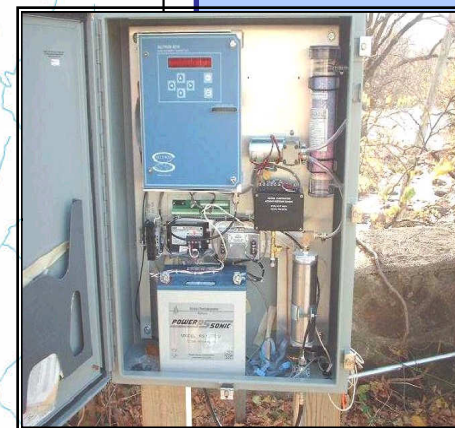
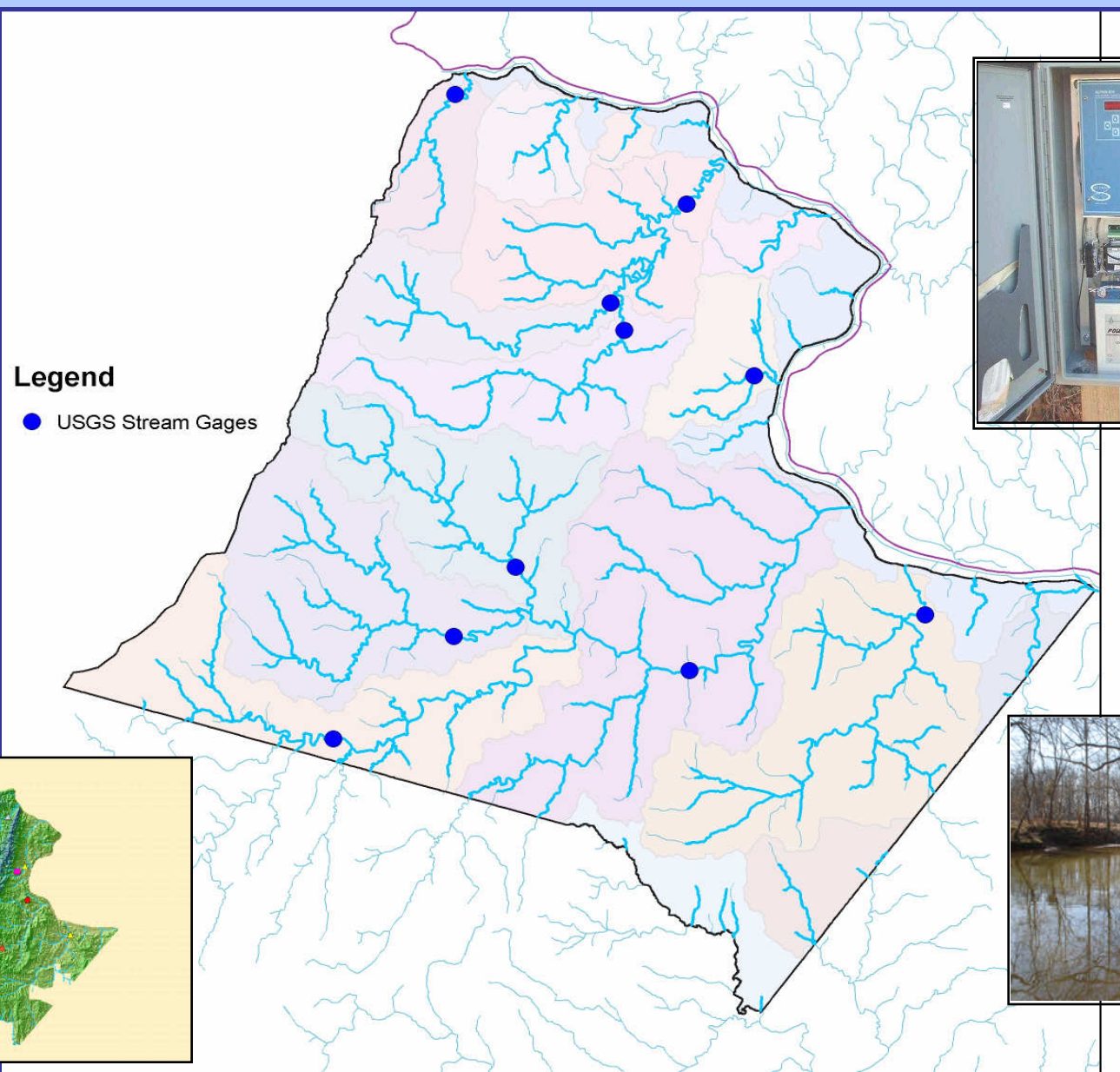


Stream Stage-Discharge

- **Stream flow at ten gaging stations**
 - **Three long-term**
 - **Seven since 2001**
- **Daily flow and 15-minute real time data**
- **Baseflow and low flow calculations**
- **Calculations of groundwater recharge**



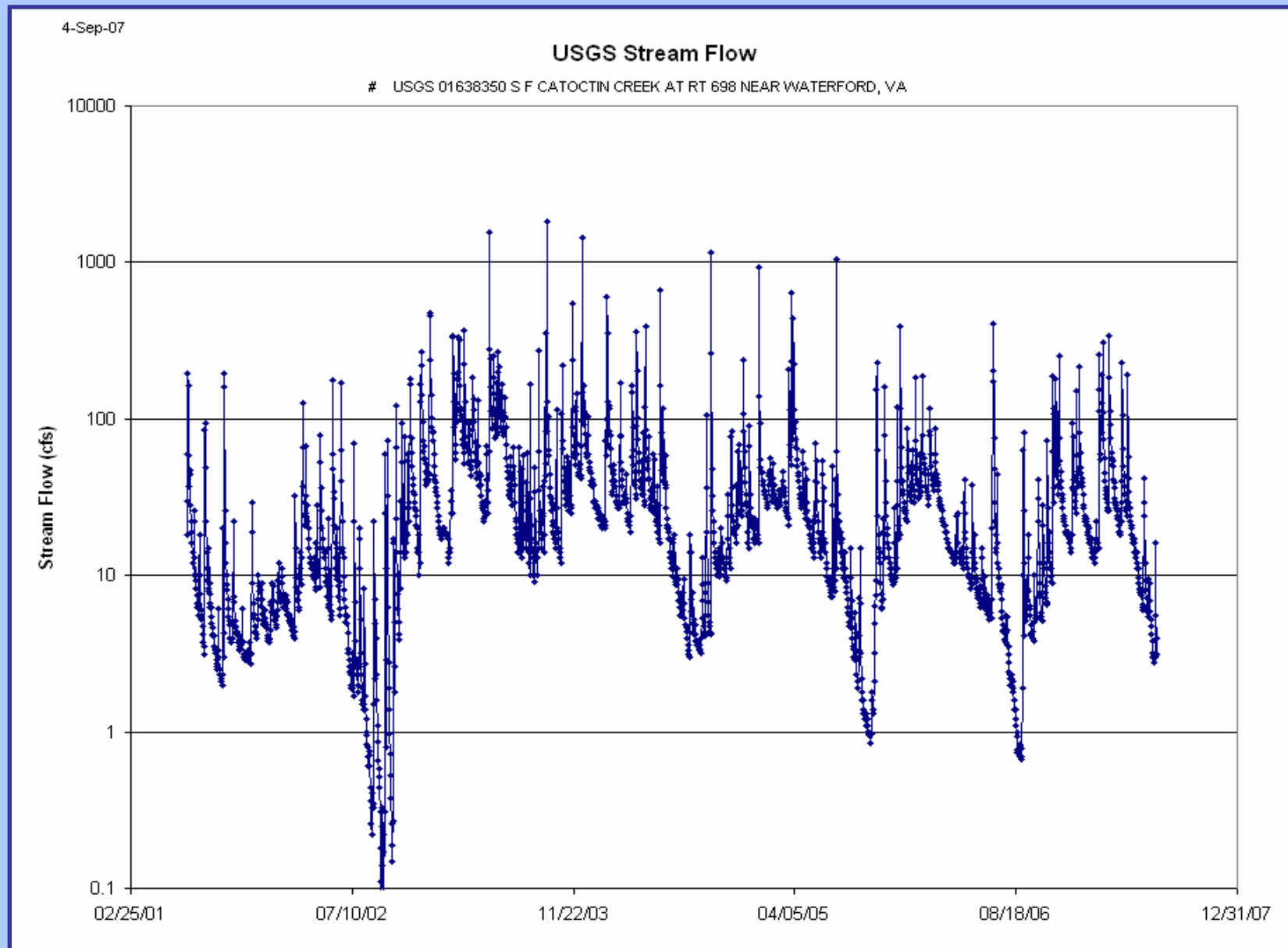
Stream Stage-Discharge

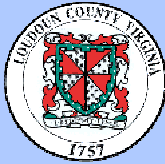




Stream Stage-Discharge

PROVISIONAL
RESULTS



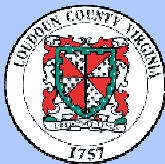


Stream Stage-Discharge

PROVISIONAL
RESULTS

01644280 BROAD RUN NEAR LEESBURG, VA

	Minimum daily flow									
		5th percentile								
			10th percentile							
				25th percentile						
					Median					
						75th percentile				
							90th percentile			
								95th percentile		
									Maximum daily flow	
										Years of record
January	7.50	8.72	12.6	24.1	34.3	58.9	515	625	855	4
February	8.71	10.0	12.4	16.7	43.1	79.6	358	528	885	3
March	8.69	27.1	33.8	43.5	92.4	238	538	577	995	4
April	16.7	23.5	25.2	47.4	74.3	228	612	792	1,320	4
May	14.8	21.9	25.7	33.6	69.9	245	431	857	1,160	4
June	10.4	12.0	17.8	30.5	71.1	127	227	400	549	4
July	2.60	3.58	7.36	18.6	43.7	80.2	216	518	697	4
August	1.64	1.85	2.92	10.3	22.7	55.0	101	117	186	4
September	3.16	3.36	3.57	4.25	25.0	75.0	251	644	870	4
October	4.81	6.50	8.41	16.3	27.5	76.1	146	265	525	3
November	3.73	3.81	4.06	30.6	86.9	238	383	508	556	4
December	6.27	13.3	17.3	30.2	95.0	191	418	598	799	4

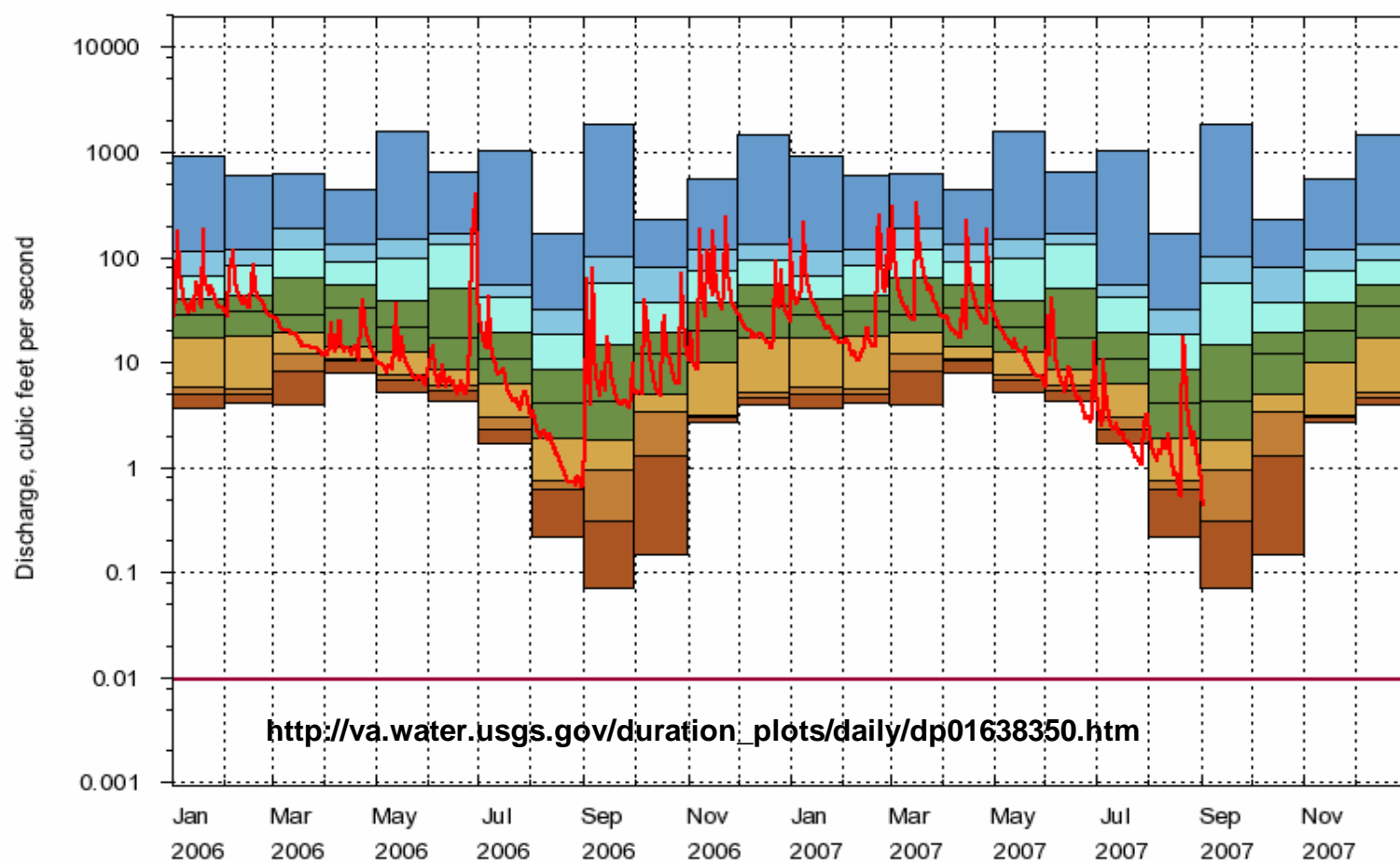


Stream Stage-Discharge

PROVISIONAL
RESULTS

On-line Streamflow Duration

01638350 SOUTH FORK CATOCTIN CREEK AT ROUTE 698 NEAR WATERFORD, VA

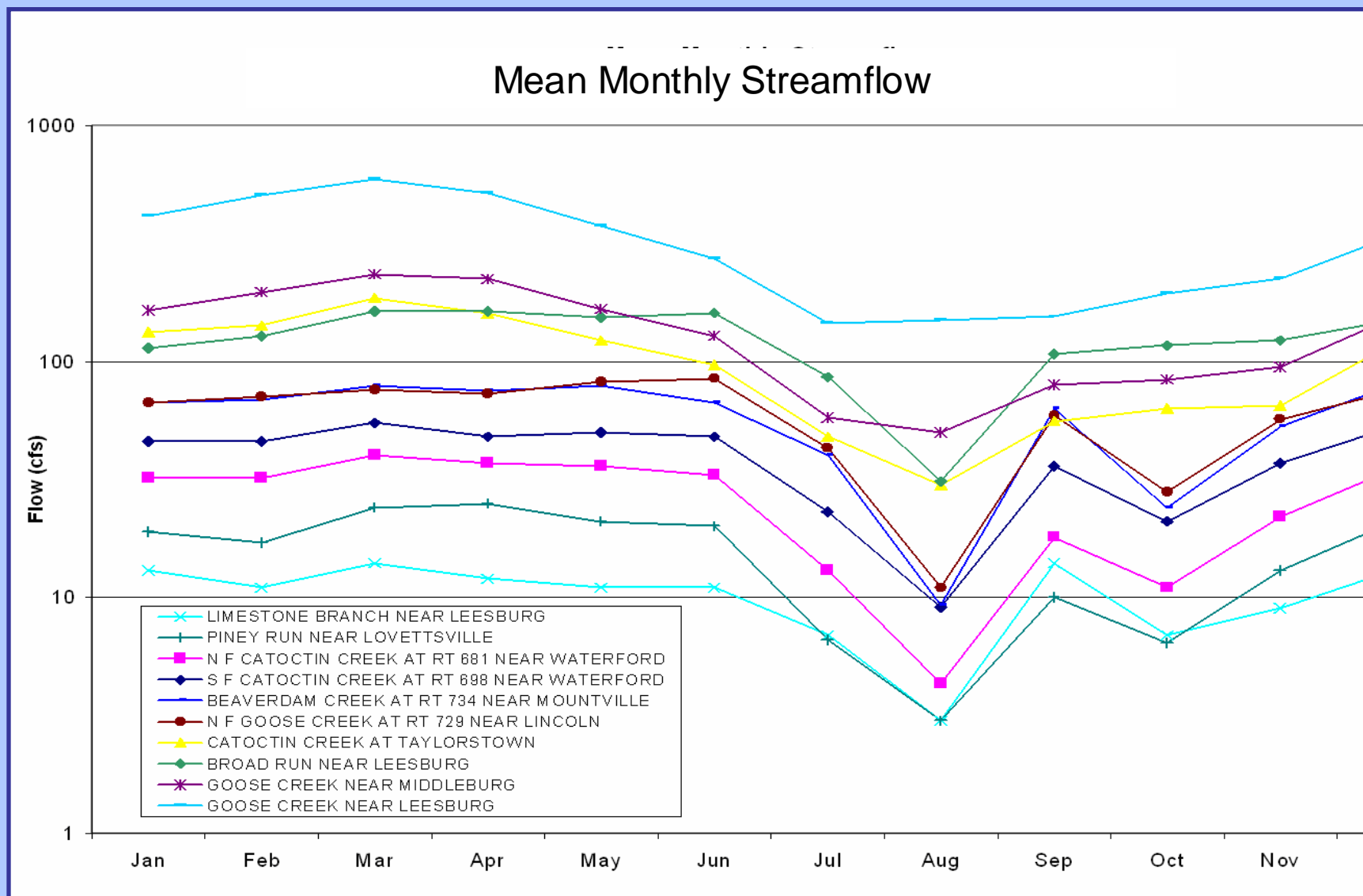


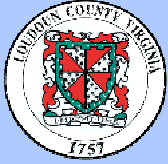
---- Provisional Data Subject to Revision ----



Stream Stage-Discharge

PROVISIONAL
RESULTS





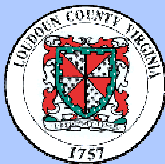
Stream Stage-Discharge

**PROVISIONAL
RESULTS**

USGS Real-time Streamflow

15-minute readings

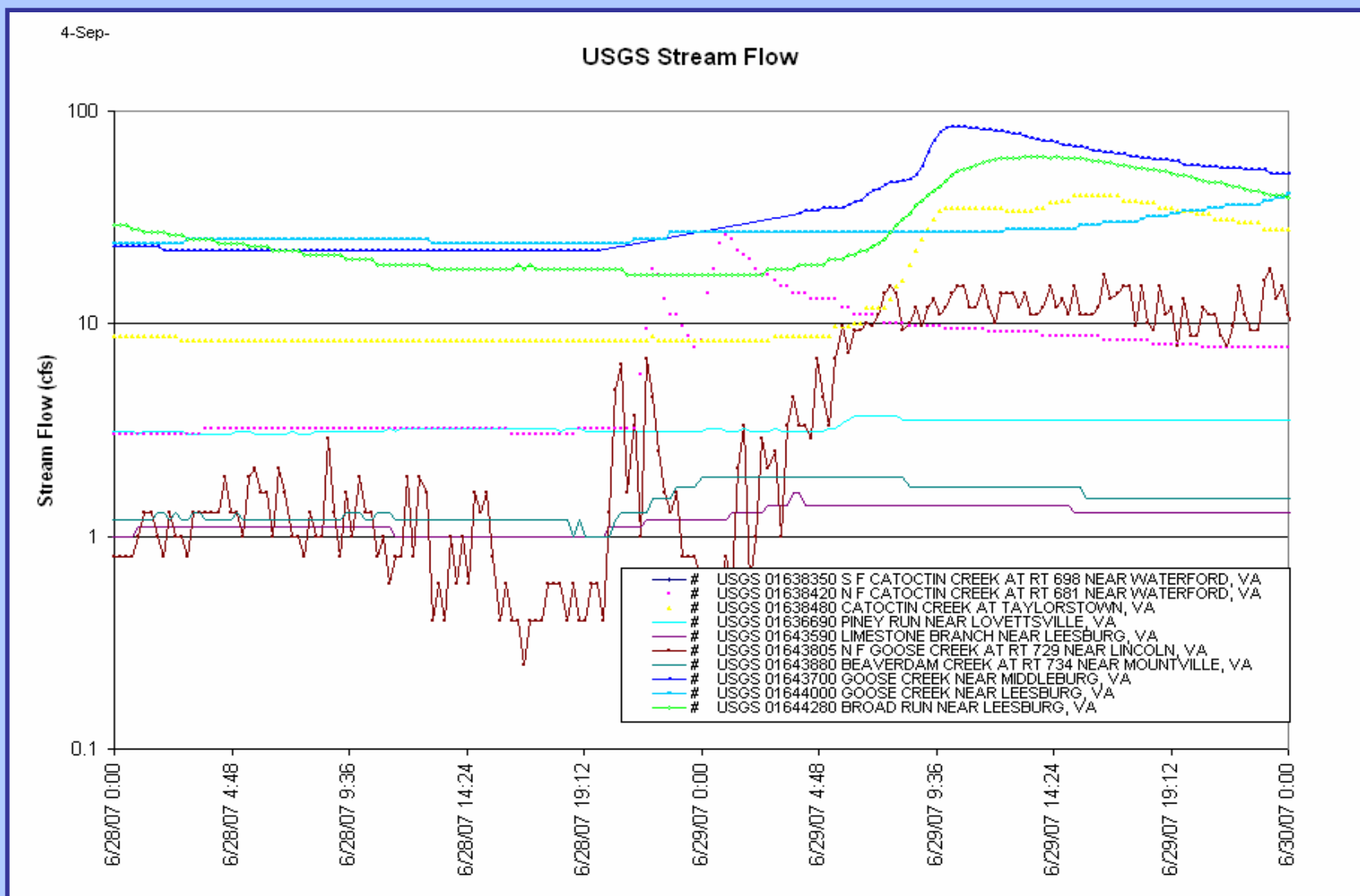
Start Date	11/19/06
End Date	08/16/07
Number of Days	270
Readings per Day	120
Number of Stations	10
Number of Readings	324,000



Stream Stage-Discharge

PROVISIONAL
RESULTS

Real-Time Data for Example Two-Day Period

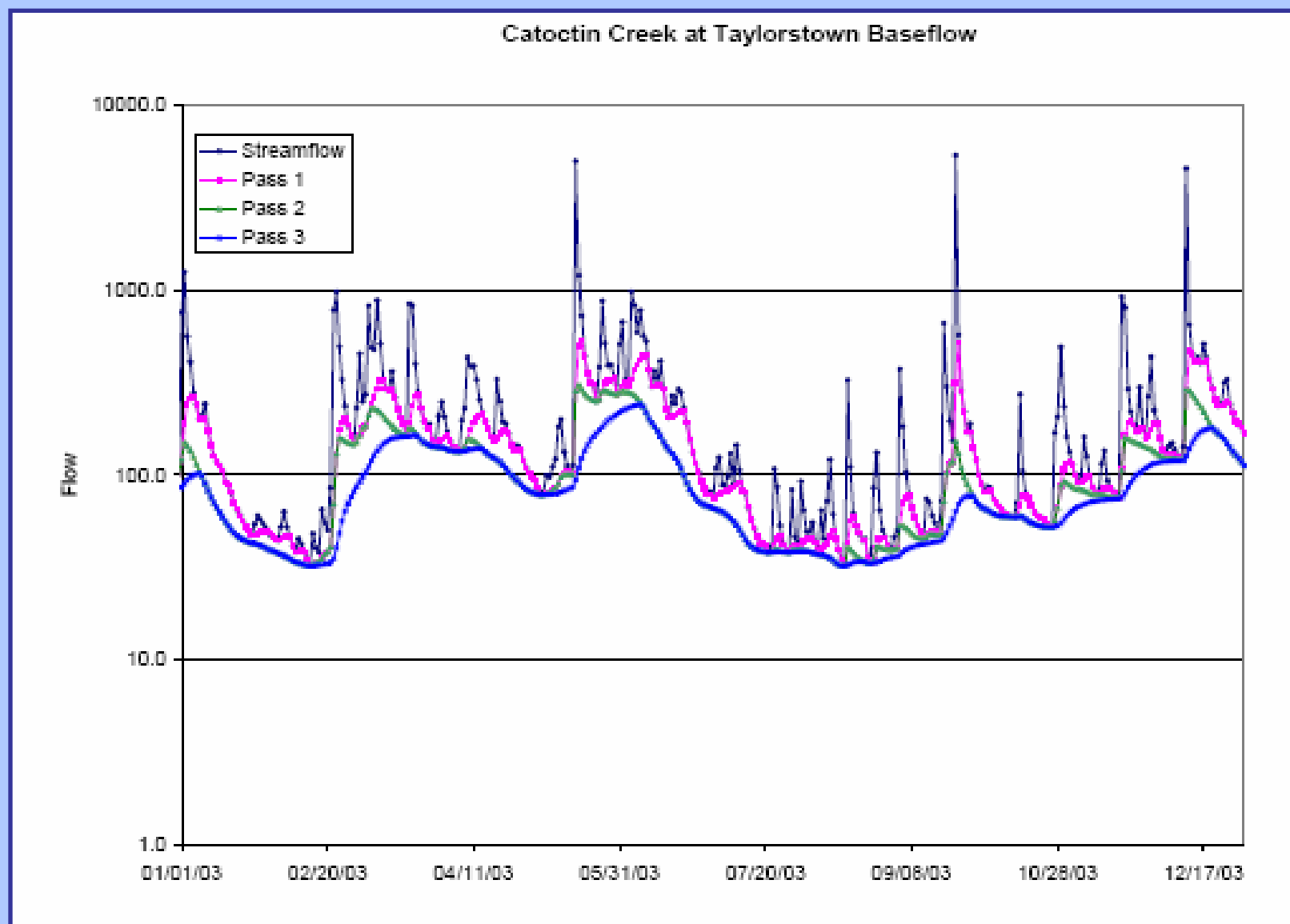




Stream Stage-Discharge

PROVISIONAL
RESULTS

Baseflow Separation





Stream Stage-Discharge

PROVISIONAL
RESULTS

Baseflow Statistics

Previously Published										Current Calculations using DFLOW3					
Station number	Station name	Period of record	Site type	Number of Discharge Values	Drainage area (mi ²)	Mean base flow (ft ³ /s)	7Q2 (ft ³ /s) Historic	7Q10 (ft ³ /s) Historic	Base-flow variability Index	Stream Gages	Station_ID	Period of record	Days in Record	7Q2 (ft ³ /s) Current	7Q10 (ft ³ /s) Current
1636690	Piney Run near Lovettsville	Prior to 1997	PR	11	13.7	8.75	0.53	0.11	0.93	Piney Run	1636690	2003-2007	1,825	1.03	
										South Fork Catoctin	1638350	2003-2007	1,825	1.78	
										North Fork Catoctin	1638420	2003-2007	1,825	0.56	
1638480	Catoctin Creek at Taylors town	1973-84	CR	-	89.6	60.6	6.8	2.9	0.75	Catoctin	1638480	1973-2007	12,782	4.81	0.63
1643585	Potomac River Tributary No 1 near Lucketts	Prior to 1997	PR	-	2.95		0.1	0.04	0.65						
1643600	Limestone Branch Tributary No 1 near Leesburg	Prior to 1997	PR	-	6.82		1.2	0.6	0.39	Limestone Branch	1643590	2003-2007	1,825	1.43	
1643700	Goose Creek near Middleburg	1967-84	CR		123	97.1	6	0.71	0.91	Goose Creek (Middleburg)	1643700	1967-2007	14,974	4.56	0.02
1643800	North Fork Goose Creek at Route 722 near Lincoln	Prior to 1997	PR	9	24		1.1	0.34		North Fork Goose Creek	1643805	2003-2007	1,825	3.07	
1643950	Goose Creek at Oatlands	Prior to 1997	PR	9	276	138	12	2.9	0.82						
1643988	Little River near Oatlands	Prior to 1997	PR	-	47.7	26	2.1	0.5	0.81						
1643990	Howlers Branch near Oatlands	Prior to 1997	PR	-	5.98		0	0		Beaverdam Creek	1643880	2003-2007	1,825	0.31	
1644000	Goose Creek near Leesburg	1931-84	CR		332	191	12	2.5	0.91	Goose Creek (Leesburg)	1644000	1911-2007	35,428	10.4	1.77

7Q10 - Seven-day, consecutive low flow with a ten year return frequency; the lowest stream flow for seven consecutive days that would be expected to occur once in ten years.

1644263	Potomac River Tributary No 2 near Sterling	Prior to 1997	PR	-	3.47		0	0				2007			
---------	--	---------------	----	---	------	--	---	---	--	--	--	------	--	--	--

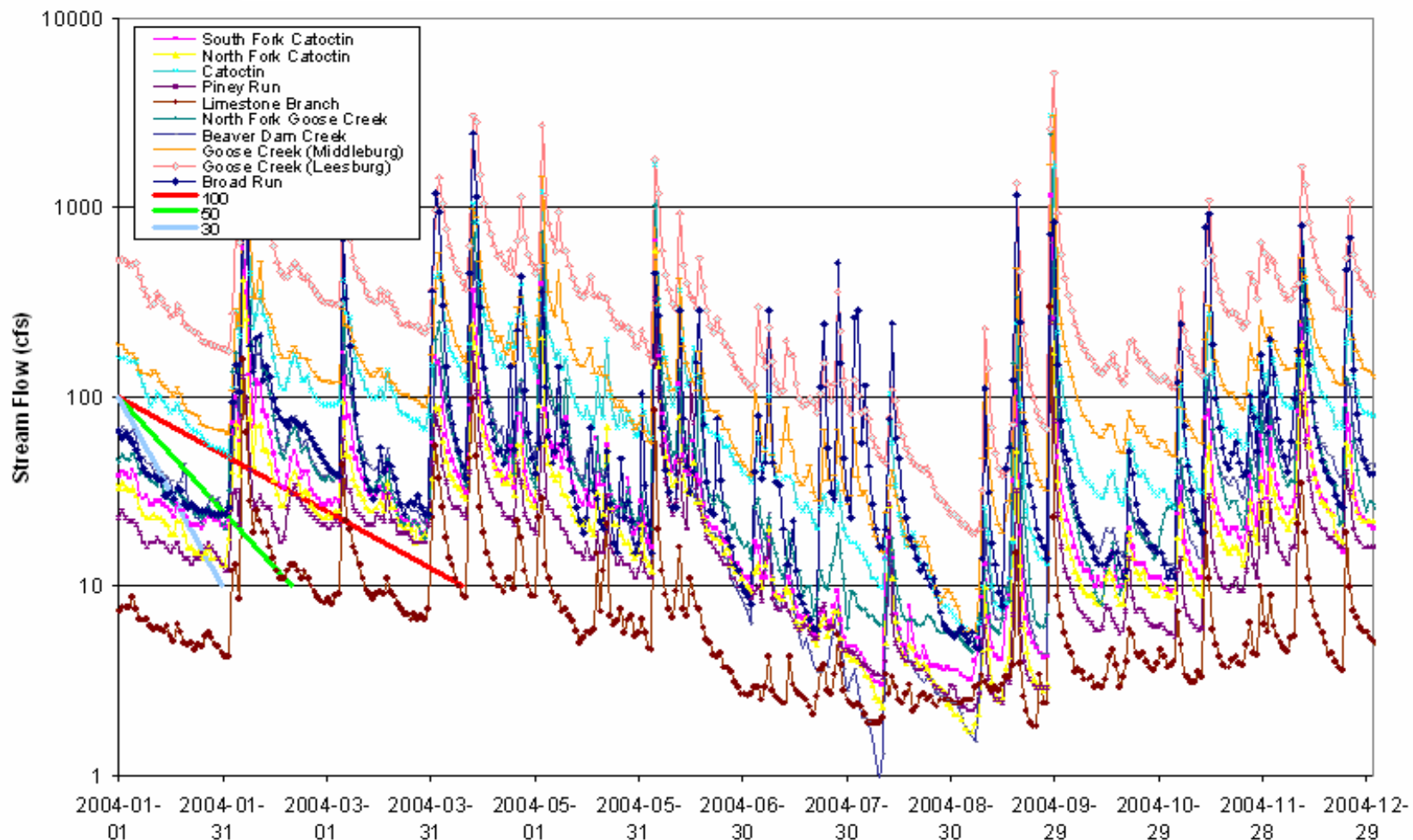


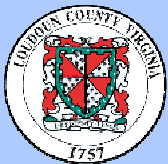
Stream Flow and Recharge

PROVISIONAL
RESULTS

22-May-07

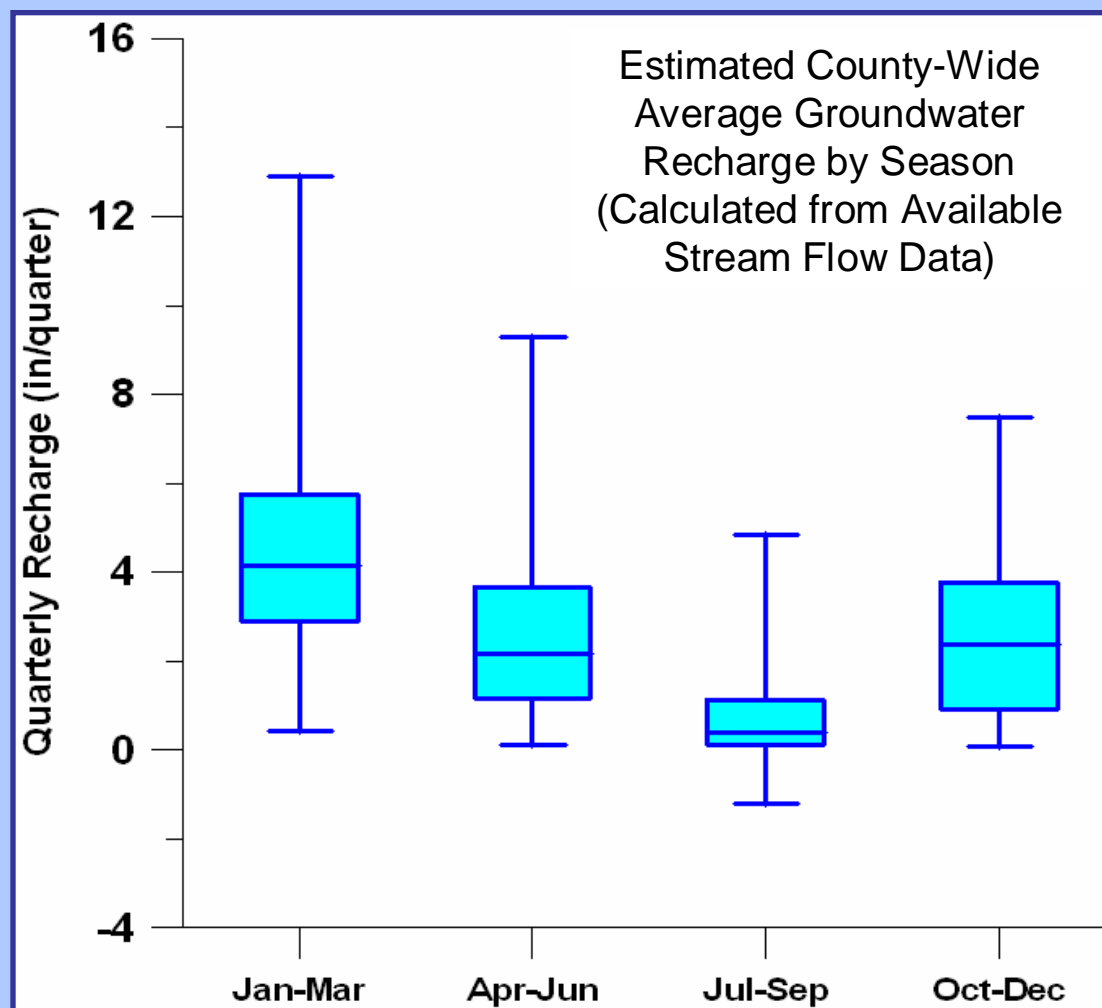
Fitting Recession Index for Recharge Calculation





Stream Flow and Recharge

PROVISIONAL
RESULTS



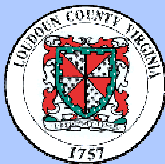


Stream Flow and Recharge

**PROVISIONAL
RESULTS**

Average Calculation of Recharge from Streamflow

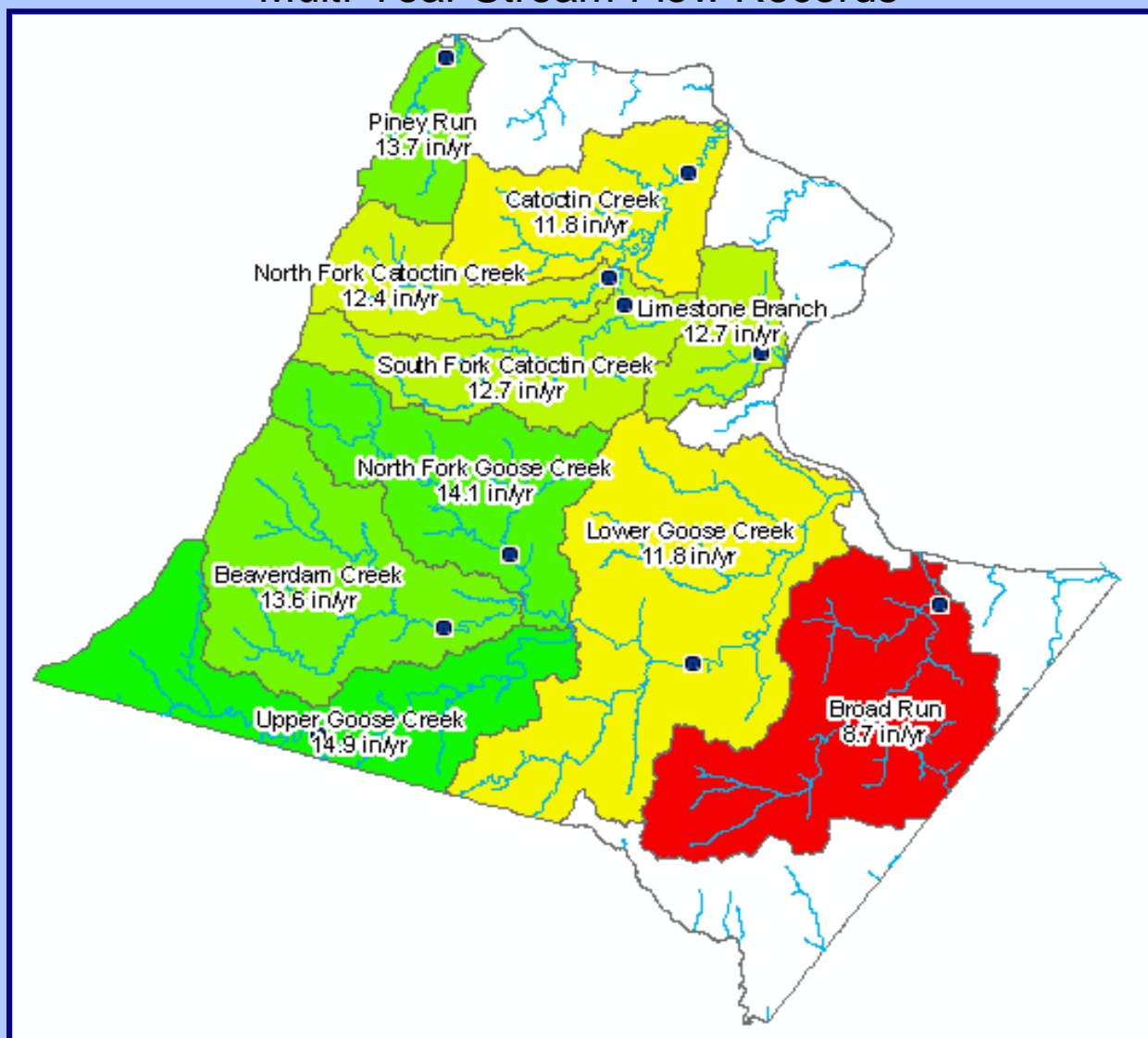
Name	Abbreviation	Site_no	Year of First Complete Record	Annual Average for Entire Record (in/yr)	Annual Average for Recent 2002-2005 (in/yr)
South Fork Catoclin	SF_Cat	1638350	2002	12.67	12.67
North Fork Catoclin	NF_Cat	1638420	2002	12.36	12.36
Catoclin	Cat	1638480	1972	10.29	11.79
Piney Run	Piney	1636690	2002	13.72	13.72
Limestone Branch	Lime	1643590	2002	12.66	12.66
North Fork Goose Creek	NF_GC	1643805	2002	14.12	14.12
Beaver Dam Creek	Beaver	1643880	2002	13.62	13.62
Goose Creek (Middleburg)	GC_Middle	1643700	1970	12.49	14.91
Goose Creek (Leesburg)	GC_Lee	1644000	1930	9.26	11.76
Broad Run	BR	1644280	2002	8.71	8.71
Average				11.99	12.63



Stream Flow and Recharge

PROVISIONAL
RESULTS

Estimated Recharge in Watersheds with
Multi-Year Stream Flow Records





Stream Flow and Recharge

PROVISIONAL
RESULTS

Calculation of Recharge Previously Published

Published Recharge Estimates

The USGS has published recharge estimates at selected sites in Loudoun County. Calculations were performed using partial records (PR) using 9 to 11 stream flow measurements and from complete records (CR) where longer term gaging stations had been established. Published data appear in publications Hayes, 1991 and Nelms, et al, 1977.

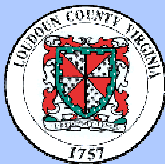
Published USGS					Calculations using RORA				
Station number	Station name	Period of record	Site type	Effective recharge (in/yr)	Period of record	Effective recharge (in/yr)	Period of record	Days in Record	Effective recharge (in/yr)
1636690	Piney Run near Lovettsville	Prior to 1997	PR	8.67			2003-2007	1,825	13.72
1638480	Catoctin Creek at Taylorstown	1973-84	CR	9.18	1973-84	10.94	1973-2007	12,782	10.29
1643700	Goose Creek near Middleburg	1967-84	CR	10.72	1967-84	13.12	1967-2007	14,974	12.49
1644000	Goose Creek near Leesburg	1931-84	CR	7.79	1931-84	8.91	1911-2007	35,428	9.263

Overall the published effective recharge values in 1984 are less than those calculated using the RORA program. The reason is likely the methodology used.



Stream Water Quality

- **DEQ Data available for 142 sampling stations in Loudoun County and contributing watersheds.**
 - 162 Parameters
 - 88,000+ Individual analyses
- **19 stations have long sampling records and were chosen for further analysis.**
- **Analysis Includes:**
 - Summary Statistics*
 - by Site
 - by Month
 - by Analyte

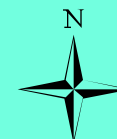


Surface Water Quality Sampling Sites: DEQ

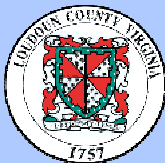
PROVISIONAL
RESULTS

Legend

- DEQ Stations - All Stations
- DEQ Stations - Long records
- Loudoun County
- BEAVERDAM CREEK
- CATOCTIN CREEK
- CUB RUN
- LOWER GOOSE CREEK/LITTLE RIVER
- MIDDLE GOOSE CREEK/PANTHER SKIN CREEK
- NORTH FORK GOOSE CREEK
- POTOMAC RIVER/BROAD RUN
- POTOMAC RIVER/LIMESTONE BRANCH
- POTOMAC RIVER/PINEY RUN/DUTCHMAN CREEK
- SUGARLAND RUN
- UPPER BULL RUN/LITTLE BULL RUN
- UPPER GOOSE CREEK
- Streams



Miles
0 2 4 8 12 16

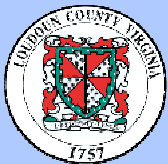


Stream Water Quality

**PROVISIONAL
RESULTS**

Summary Statistics for DEQ Surface Water Quality Data

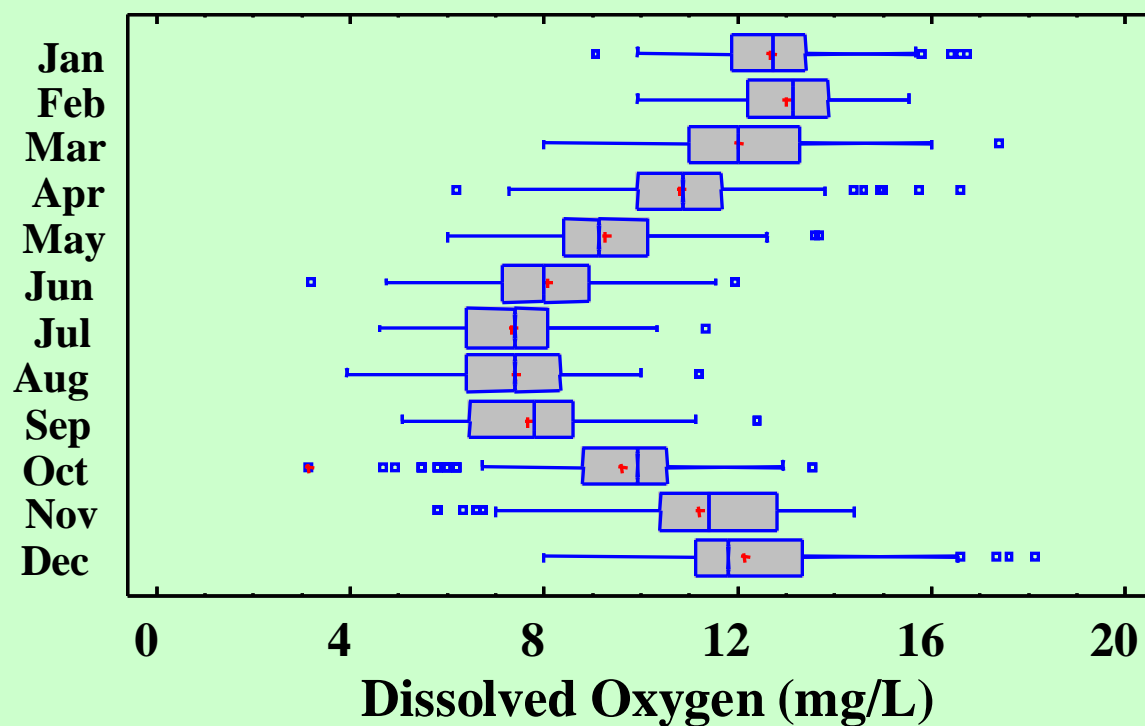
ParameterName	Count	Mean	Median	Standard deviation	Coeff. of variation	Minimum	Maximum	Range	Lower quartile	Upper quartile	Interquartile range	Std. skewness
Field Turbidity (NTU)	1100	13.74	6.20	53.14	387%	0.83	1540	1539.17	3.93	10.8	6.87	307.61
Specific Conductance (uS/cm)	1659	206.40	171.00	120.57	58%	31.1	1893	1861.9	135.2	235	99.8	61.1711
BOD 5 DAY (mg/L)	2981	2.39	2.00	2.57	107%	0.04	54	53.96	1	2	1	152.092
COD (mg/L)	2145	13.23	11.00	11.34	86%	0	181	181	7	16	9	121.035
pH (standard units)	1950	6.97	7.04	0.63	9%	0	10.28	10.28	6.69	7.39	0.7	-24.7585
Tot. Alkalinity as CaCO3 (mg/L)	1955	51.51	42.00	30.27	59%	0	321	321	30	66	36	28.409
Total Residue (mg/L)	2101	153.22	127.00	102.37	67%	0	2167	2167	102	177	75	159.905
Total Nitrogen (mg/L)	550	1.28	1.23	0.48	38%	0.18	3.21	3.03	0.92	1.56	0.64	5.43584
NH3-N Total (mg/L)	4585	0.25	0.10	1.06	428%	0	22.5	22.5	0.04	0.1	0.06	299.447
NO2-N Total (mg/L)	4120	0.06	0.01	0.49	830%	0	28	28	0.01	0.02	0.01	1225.59
NO3-N Total (mg/L)	3541	1.18	0.95	1.27	107%	0	27	27	0.49	1.5	1.01	139.759
Total Kjeldahl N (mg/L)	4122	0.78	0.40	3.56	458%	0.01	183.9	183.89	0.3	0.6	0.3	978.755
NO2 and NO3 N-TOTAL	1048	1.13	0.98	0.87	77%	0.02	9	8.98	0.55	1.5	0.95	34.7571
Total Phosphorous (mg/L P)	3344	0.11	0.10	0.18	161%	0.01	4.8	4.79	0.05	0.1	0.05	311.426
Dissolved PO4 (mg/L P)	1392	0.22	0.03	5.42	2510%	0	202	202	0.02	0.06	0.04	567.392
Total Organic Carbon (mg/L)	2201	6.31	5.10	4.52	72%	0	62	62	3.66	8	4.34	75.8208
Total Hardness (mg/L CaCO3)	1804	72.98	60.50	41.00	56%	0.45	523	522.55	47	89.55	42.55	47.477
Dissolved Calcium (mg/L)	37	15.14	14.00	9.84	65%	1	45.6	44.6	9.6	16.8	7.2	3.03151
Total Chloride (mg/L)	1567	17.64	11.50	22.06	125%	0	295	295	8.2	18.2	10	90.0417
Total SO4 (mg/L)	1487	15.95	14.30	8.57	54%	0	144	144	11.1	19	7.9	70.6968
Total Fluoride (mg/L)	399	0.18	0.12	0.13	72%	0.03	0.6	0.57	0.1	0.2	0.1	13.4323
Dissolved Silica (mg/L)	511	12.52	12.60	3.80	30%	2.1	40	37.9	10.1	15	4.9	5.16463
Dissolved Arsenic (ug/L)	29	0.75	0.21	1.48	198%	0.1	5	4.9	0.1	0.4	0.3	5.86973
Total Arsenic (ug/L)	306	3.78	2.00	3.39	90%	0	11	11	1	5	4	7.96366
Total Cadmium (ug/L)	319	7.48	10.00	4.16	56%	0	32.99	32.99	2.5	10	7.5	-0.2731
Dissolved Chromium (ug/L)	29	2.53	0.10	9.48	374%	0.1	50	49.9	0.1	0.18	0.08	10.6447
Total Chromium (ug/L)	392	11.40	10.00	10.23	90%	0	50	50	10	10	0	24.6907
Total Copper (ug/L)	390	13.33	10.00	11.46	86%	0	99.99	99.99	10	10	0	29.1161
Total Iron (ug/L)	132	484.00	350.00	380.48	79%	70	3010	2940	263.96	612.5	348.54	14.4879
Dissolved Iron (ug/L)	29	197.76	100.00	370.14	187%	15	2030	2015	85	174	89	10.3262
Dissolved Lead (ug/L)	29	0.61	0.10	1.52	250%	0.1	5	4.9	0.1	0.1	0	6.0425
Total Lead (ug/L)	373	8.06	8.00	10.25	127%	0	164.9	164.9	3	10	7	80.6338



Stream Water Quality

PROVISIONAL
RESULTS

*Box-and-Whisker Plot:
DEQ Stream Samples DO by Month*

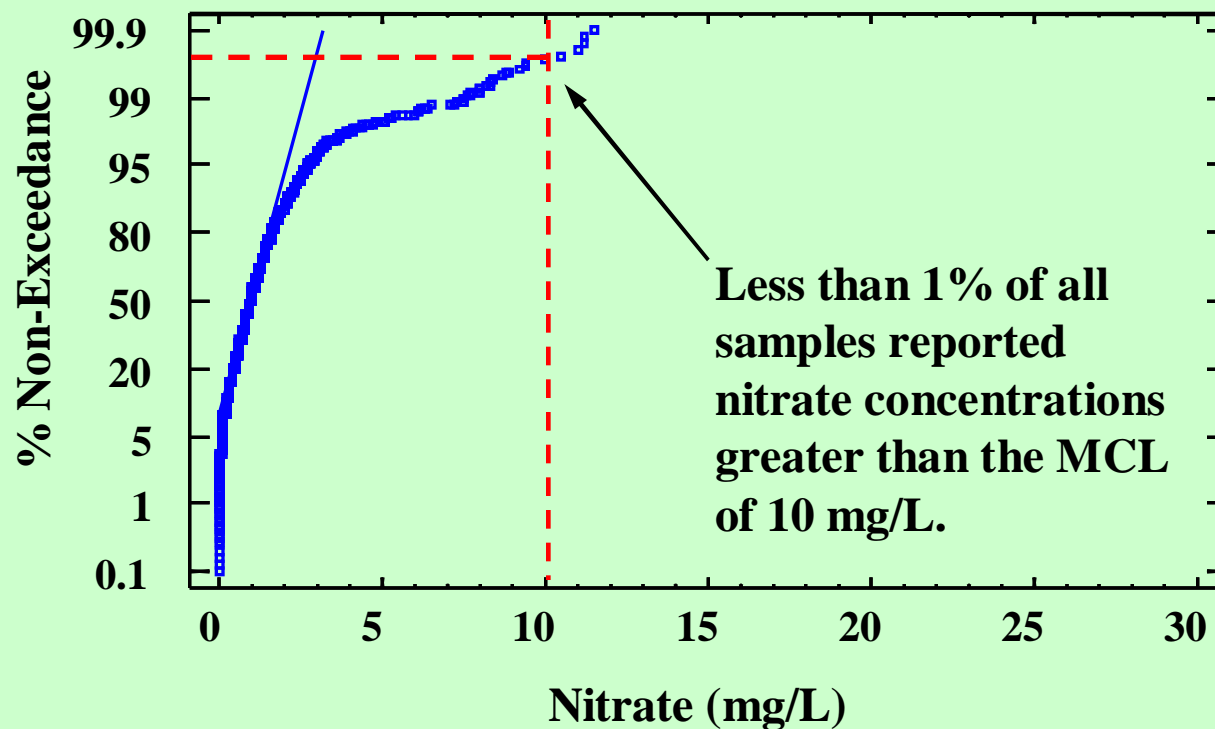


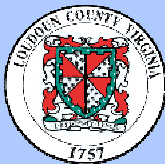


Stream Water Quality

PROVISIONAL
RESULTS

Normal Probability Plot

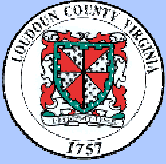




Statistical Analysis of DEQ Sediment Samples

**PROVISIONAL
RESULTS**

	Count	Mean	Median	Standard Deviation	Minimum	Maximum	Range	Standard Skewness	Standard Kurtosis
Arsenic	155	7.49	5.00	9.402	0.9	50	49.1	17.68	29.59
Beryllium	122	3.92	5.00	1.787	0.52	10	9.48	-2.42	-0.33
Cadmium	155	2.59	1.00	2.396	0.06	10	9.94	1.13	-3.78
Chromium	155	27.09	25.80	12.911	7.4	75.1	67.7	8.15	8.63
Copper	154	23.94	20.85	14.029	4.5	88	83.5	9.02	12.30
Lead	154	21.21	14.55	25.893	4.4	286	281.6	37.76	182.93
Manganese	76	708.40	670.00	319.175	105	1730	1625	2.58	1.30
Nickel	154	14.47	14.00	6.953	2.1	42	39.9	3.74	2.79
Silver	79	4.44	5.00	1.394	1	5	4	-7.71	4.68
Zinc	155	61.22	59.40	30.669	7	240	233	9.23	20.43
Antimony	65	9.65	5.00	7.981	5	32	27	5.02	1.57
Aluminum	65	13650	13200	4525.450	4800	24200	19400	0.76	-1.15
Selenium	121	2.27	1.00	4.304	0.9	34	33.1	23.44	68.49
Thallium	121	5.06	5.00	2.332	1	22	21	14.84	52.10
PCP (ug/kg)	86	81.64	80.00	39.945	0.01	190	189.99	-0.29	0.48
Aldrin (ug/kg)	116	30.97	20.00	35.904	0	120	120	4.35	-1.01
DDD (ug/kg)	82	102.19	50.00	440.307	0.1	4030	4029.9	33.20	149.87
DDE (ug/kg)	82	51.64	48.50	32.813	0.1	110	109.9	0.86	-2.08
DDT (ug/kg)	82	51.58	43.00	32.017	0.1	100	99.9	1.26	-1.98
Dieldrin (ug/kg)	86	48.48	30.00	36.629	0.1	120	119.9	1.51	-2.72
Endrin (ug/kg)	86	131.51	70.00	538.662	0.1	5055	5054.9	34.81	160.92
Toxaphene (ug/kg)	82	290.98	170.00	305.965	1	1000	999	5.75	2.37
Heptachlor (ug/kg)	86	29.05	20.00	28.262	0.1	100	99.9	4.04	0.67
Total PCBs (ug/kg)	85	208.58	89.00	253.679	1	1000	999	6.06	4.25
Atrazine (ug/kg)	41	0.03	0.00	0.045	0	0.1	0.1	2.84	-1.13
Mercury	146	0.26	0.30	0.127	0.06	0.96	0.9	9.04	19.04

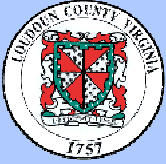


Groundwater and Wells

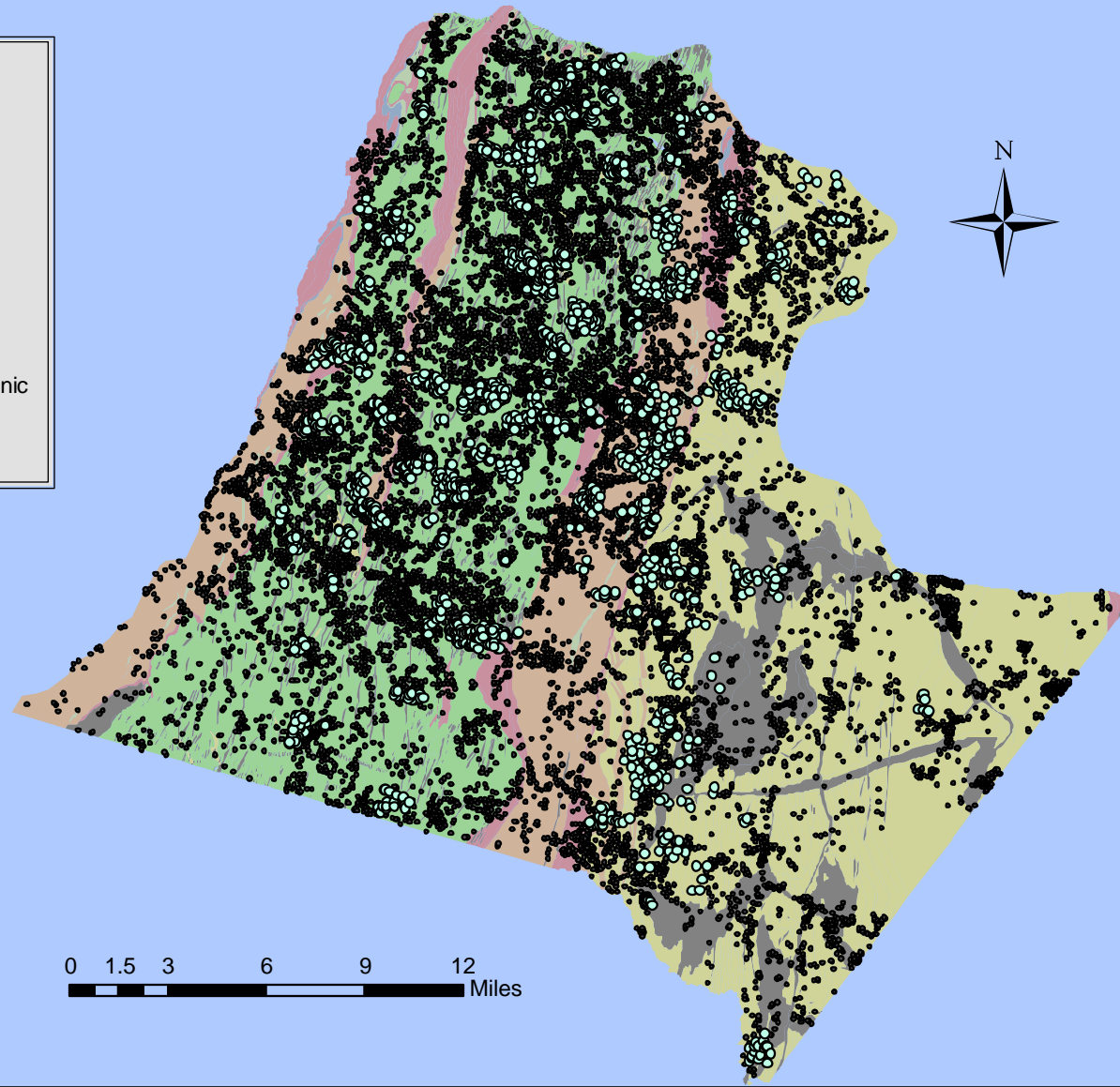
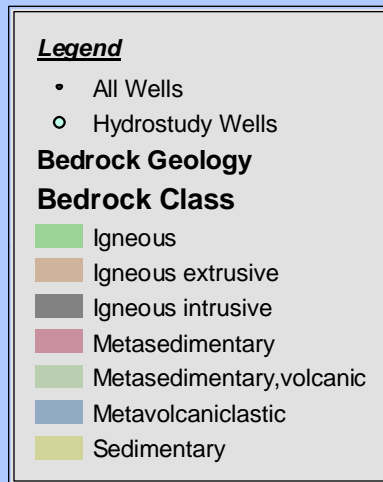
Two Sources of Groundwater Well Data:

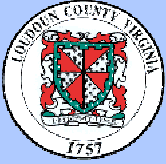
- *Health Department Data*
 - Over 19,000 total well records
 - 16,000+ records with “Active” or “Installed” status

- *County Hydrogeologic Study Requirement*
 - 163 hydrogeologic study reports submitted since mid-1980s
 - ~ 2000 total test wells
 - Most hydrostudy test wells are included in Health Dept. records



Groundwater and Wells



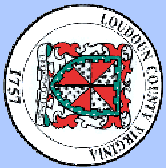


Groundwater and Wells

PROVISIONAL
RESULTS

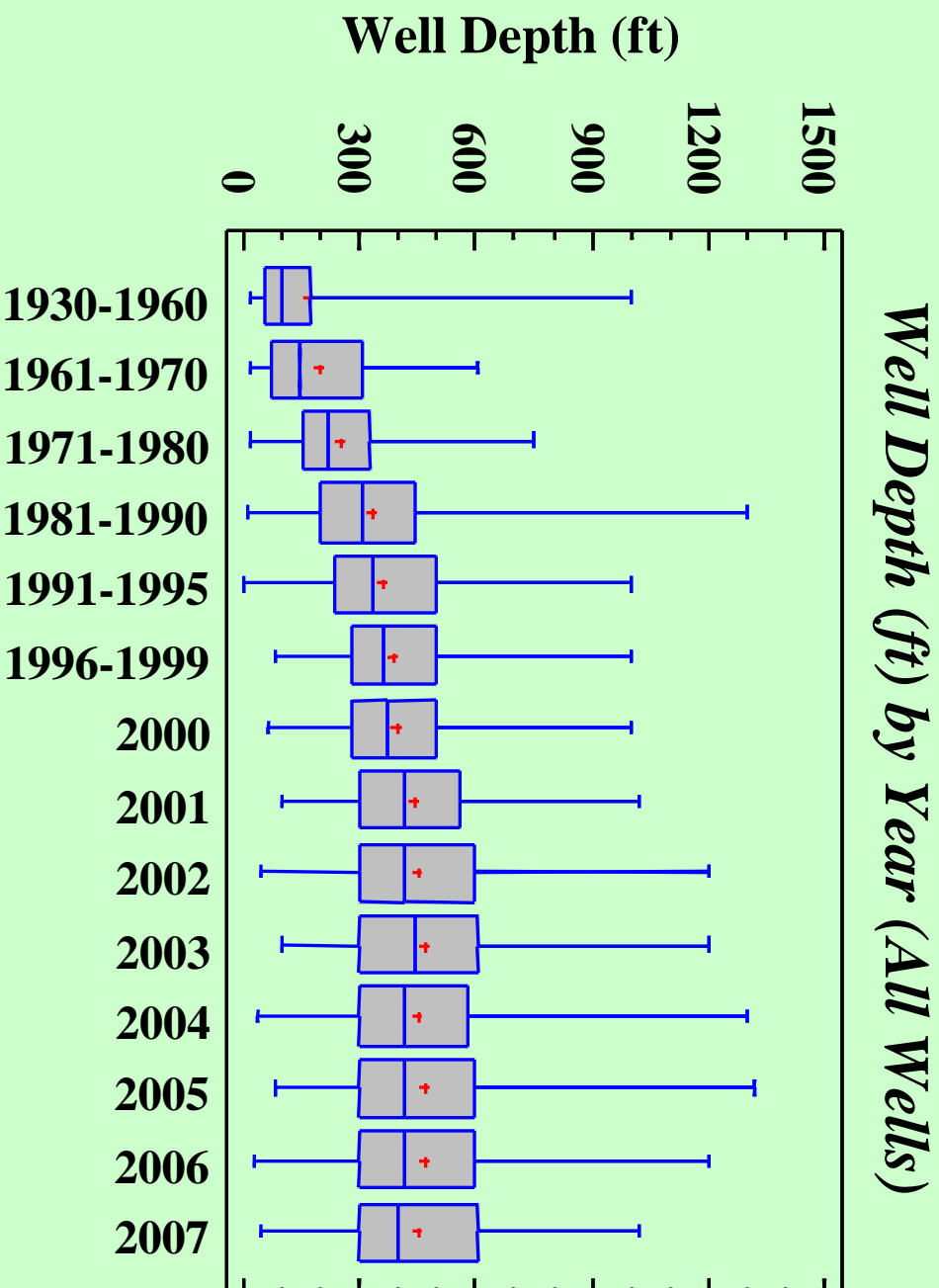
Types of Analysis:

- **Comparison of HD dataset to Hydrostudy dataset**
- **Historical Trends in Well Data**
 - Well Depth by Year
 - Static Water Level by Year
 - Dry Holes
- **Well Yield characteristics from Hydrostudy Data**
 - Yields
 - Specific Capacity
 - Transmissivity
 - Storativity
 - Yield Zones
- **Well Data by Rock Classification**



Groundwater and Wells

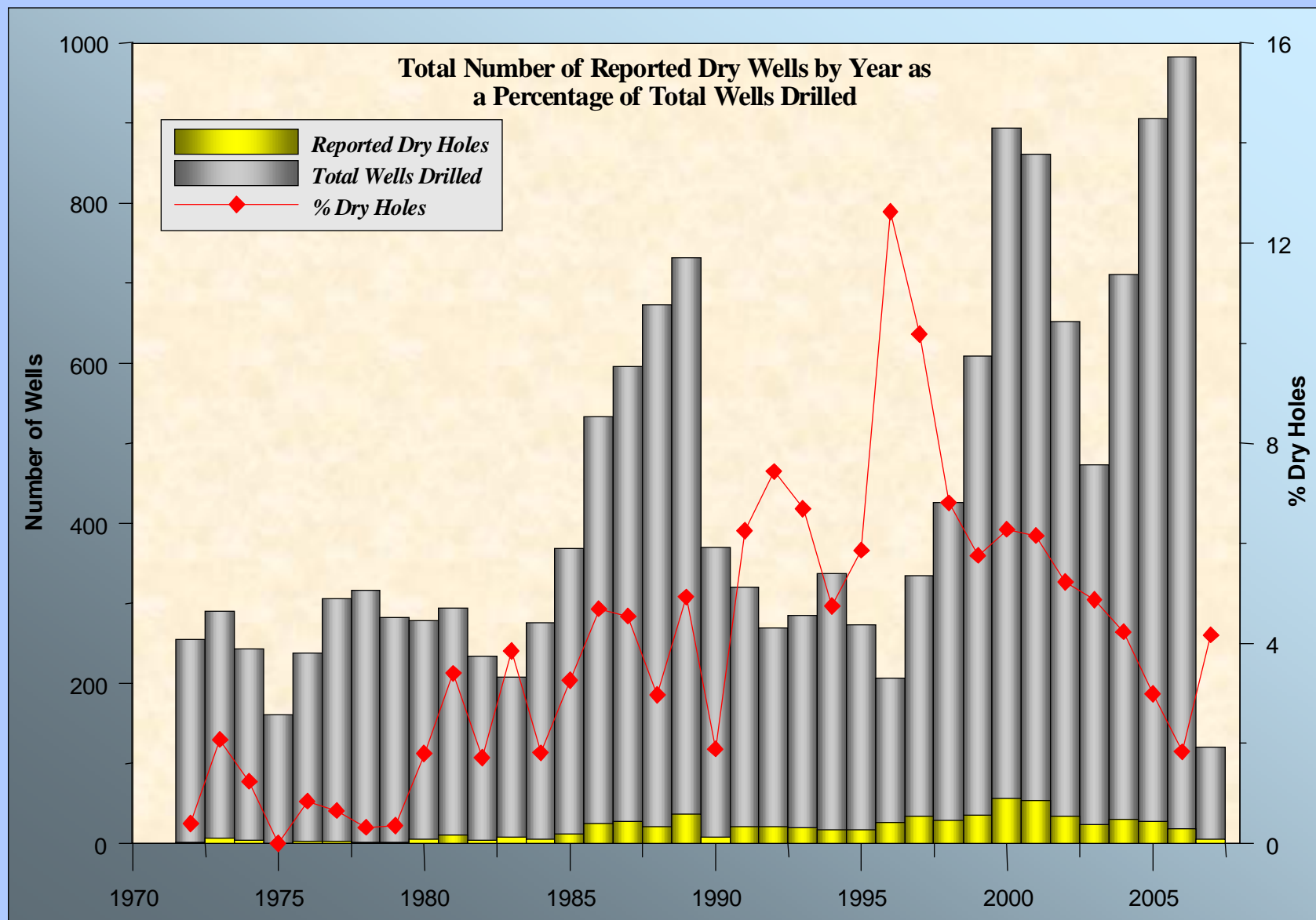
PROVISIONAL
RESULTS

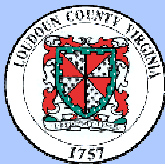




Groundwater and Wells

PROVISIONAL
RESULTS

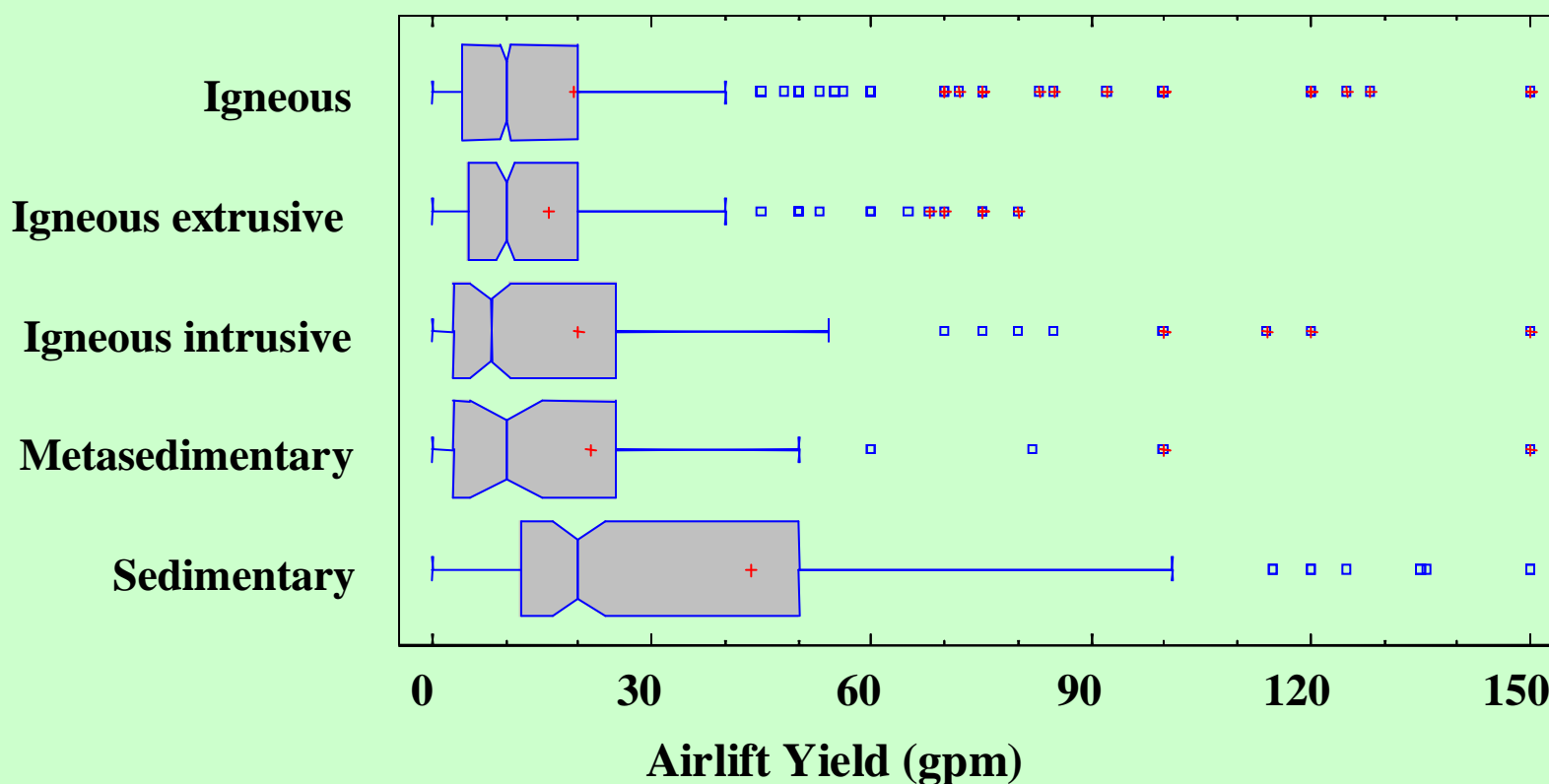


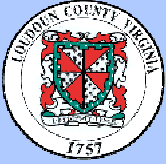


Groundwater and Wells

PROVISIONAL
RESULTS

Graphical Analysis of Physical Data
Airlift Yield by Rock Class (Hydrostudy Data)

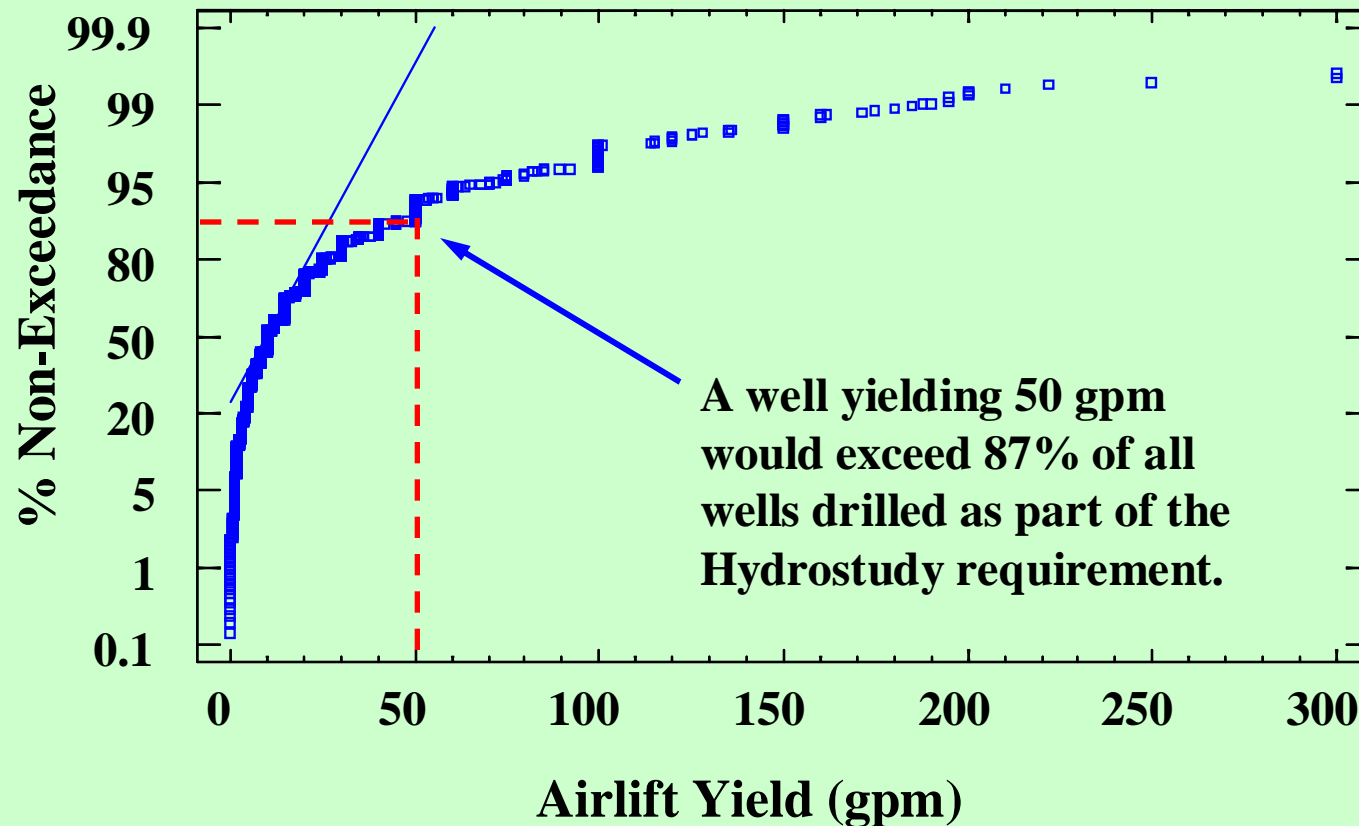


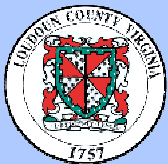


Groundwater and Wells

PROVISIONAL
RESULTS

*Normal Probability Plot
Airlift Yield (Hydrostudy Data)*

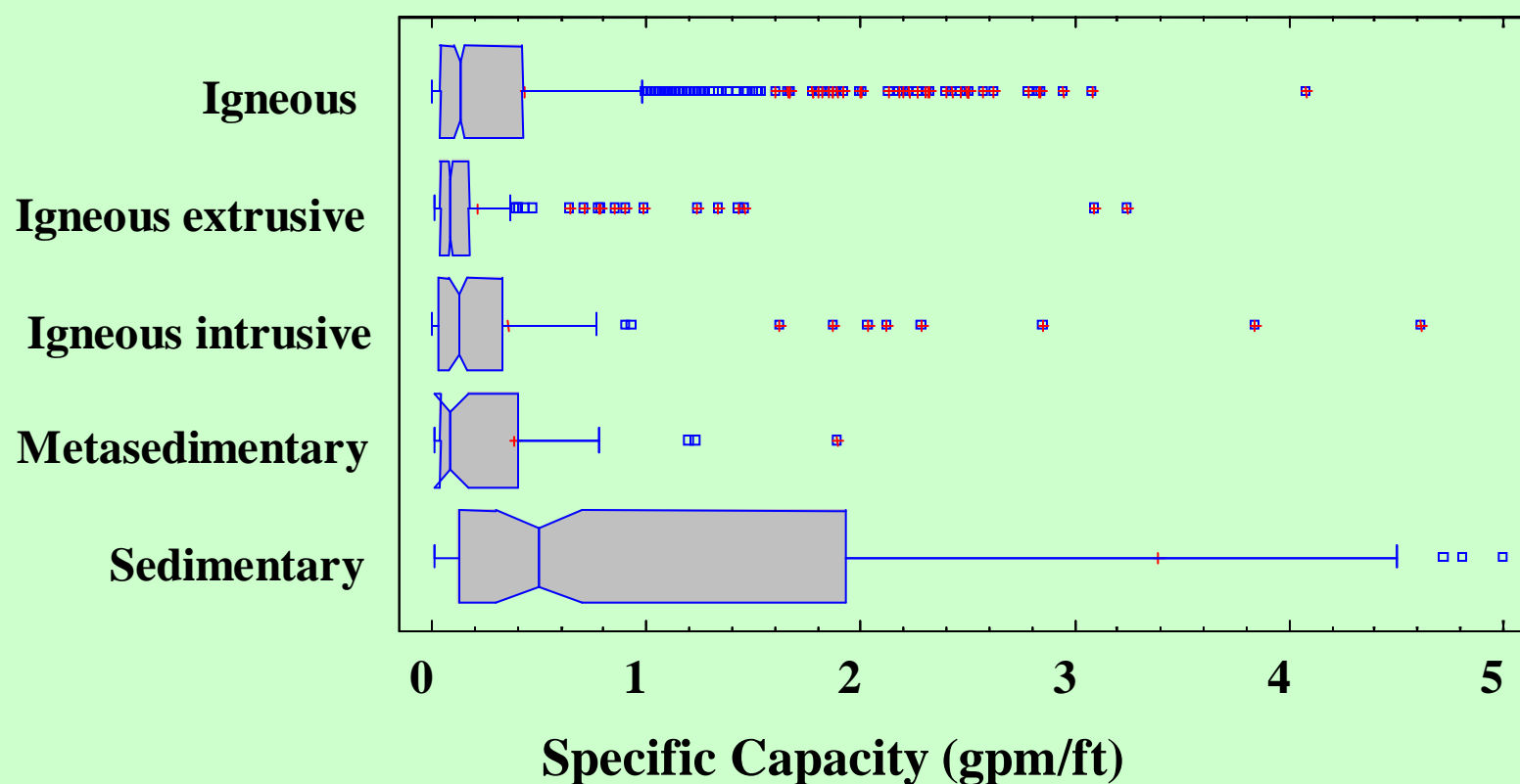


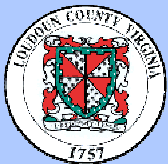


Groundwater and Wells

PROVISIONAL
RESULTS

Specific Capacity by Rock Class (Hydrostudy Data)

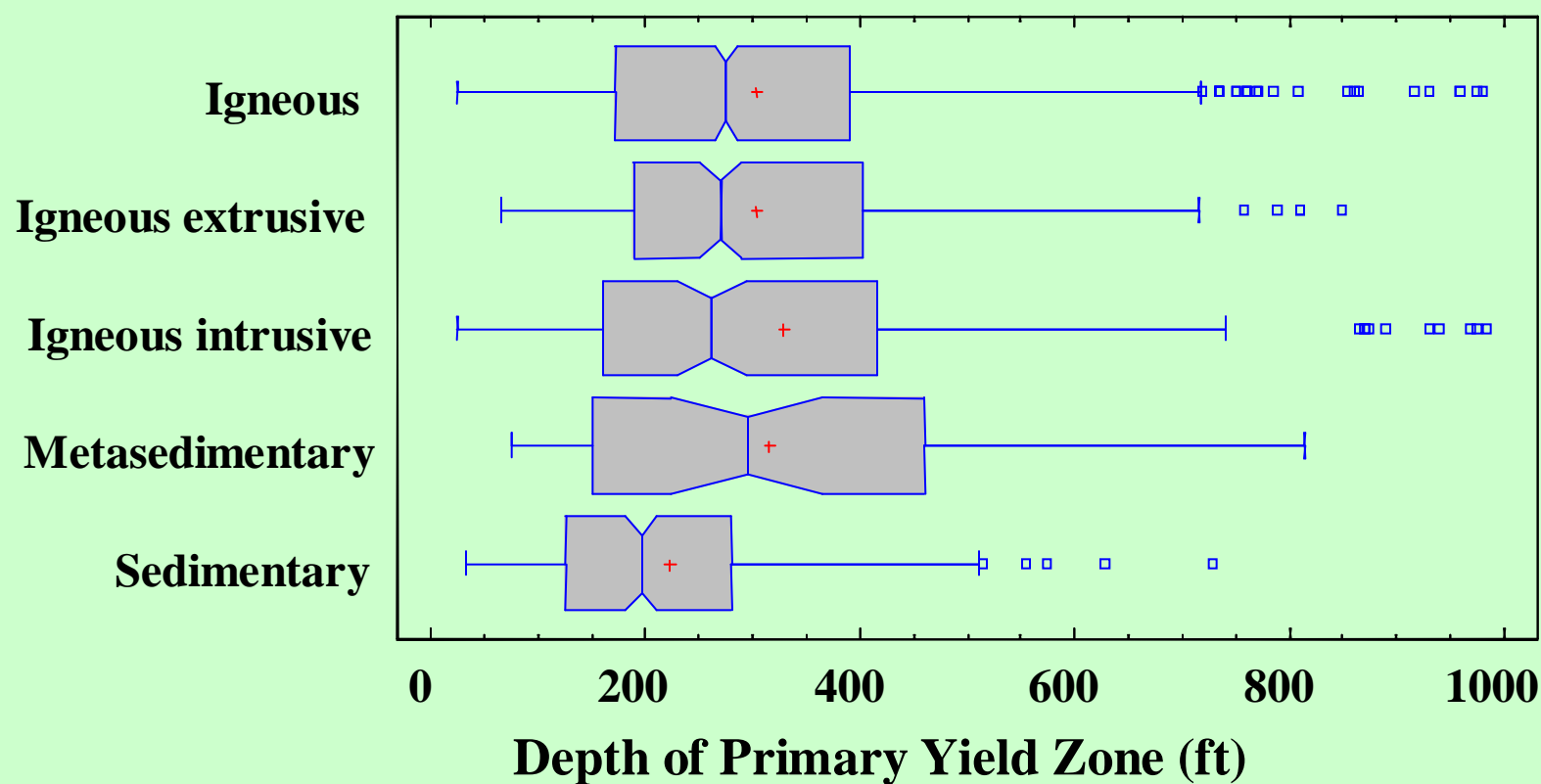


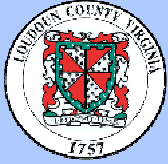


Groundwater and Wells

PROVISIONAL
RESULTS

*Depth of Primary Yield Zone
by Rock Class (Hydrostudy Data)*

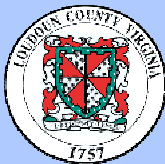




Groundwater Quality

Groundwater Quality Samples from Health Department Permitting Requirements:

- **Samples reported from over 4,700 wells**
- **98 Analytes per sample**
- **More than 200,000 individual Analyses**
- **Only 25 of 98 analytes had >1% detections**



PROVISIONAL RESULTS

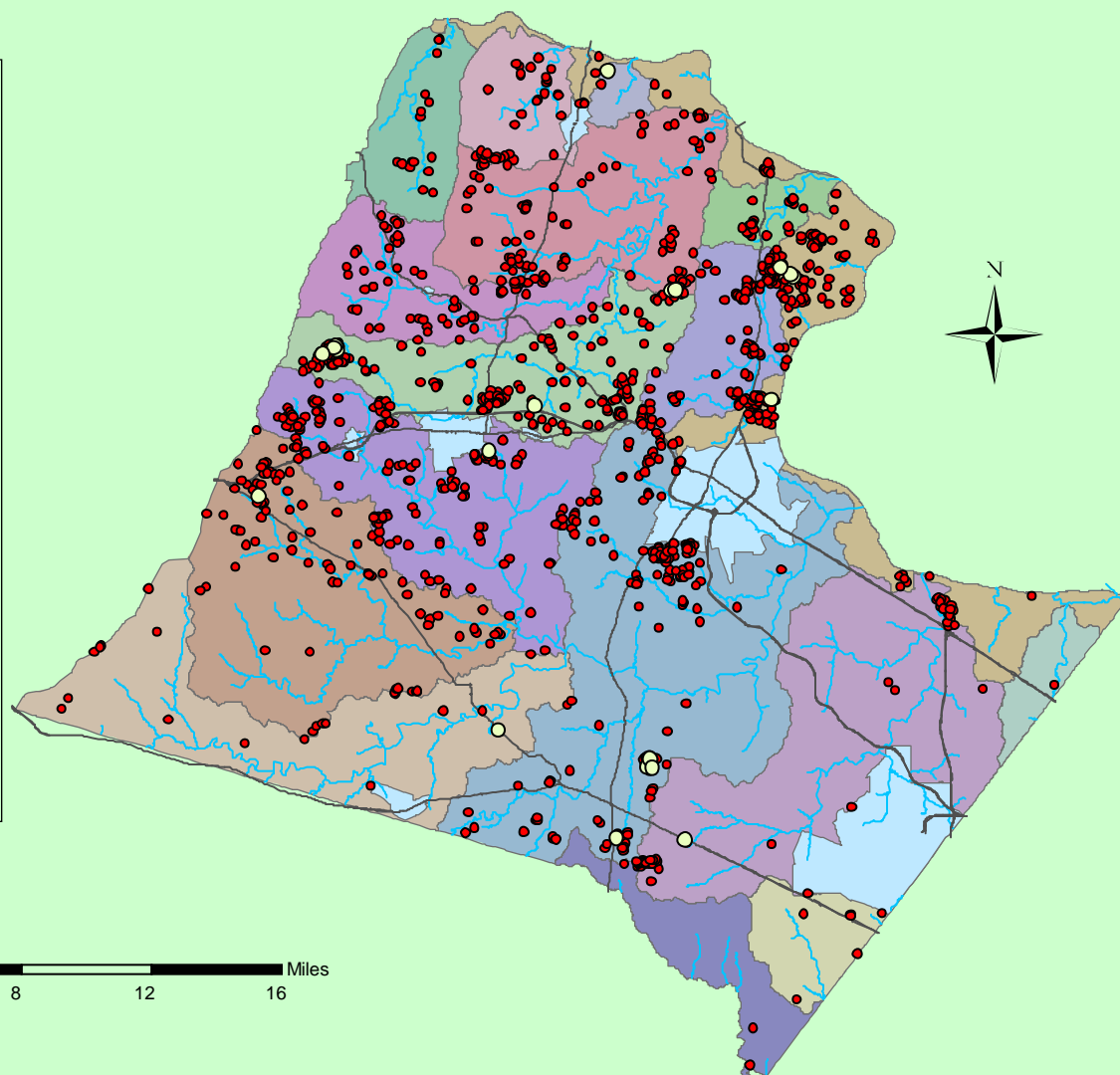
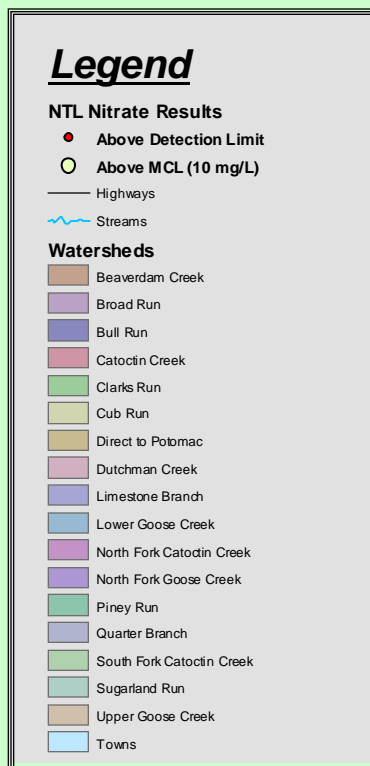
Summary Statistics for Groundwater Quality Results from National Testing Laboratories.

	Count	Mean	Median	Geometric mean	Standard deviation	Minimum	Maximum	Range	Std. skewness	Std. kurtosis
pH*	1799	7.58	7.60	7.54	0.70	5	12	7	15.39	36.04
Alkalinity	1800	106.4	100.0	96.5	53.38	6.2	1100	1093.8	95.81	717.59
Calcium	1475	28.1	25.0	23.4	24.33	1	630	629	189.12	2071.77
Chloride	1800	8.1	2.5	4.8	16.26	2.5	440	437.5	228.02	2538.41
Aluminum	1795	0.19	0.05	0.09	0.49	0.05	9.7	9.65	159.92	1085.66
Fluoride	1795	0.33	0.25	0.28	0.37	0.25	8.3	8.05	199.12	1691.53
Iron	1460	2.13	0.98	0.84	3.13	0.01	32	31.99	55.33	145.68
Magnesium	1475	8.48	7.10	6.84	5.64	0.002	56	55.998	36.69	78.14
Manganese	1458	0.14	0.11	0.07	0.15	0.002	2	1.998	51.51	182.34
Nitrate	1474	0.90	0.25	0.42	1.94	0.25	29	28.75	101.94	523.74
Sulfate	1475	13.3	10.0	8.8	27.13	2.5	660	657.5	245.29	2431.15
TDS	1793	132.6	120.0	119.2	77.84	2	1600	1598	116.28	809.31
Turbidity**	1789	16.29	5.00	4.79	43.31	0.05	1000	999.95	187.88	1589.77
Zinc	1793	0.014	0.002	0.004	0.10	0.002	3.6	3.598	456.33	7315.99
Sodium	1474	9.56	7.00	7.57	9.65	0.5	140	139.5	91.67	437.66
Copper	1794	0.011	0.002	0.003	0.09	0.002	3.3	3.298	478.52	7589.63

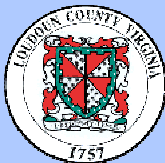


Groundwater Quality

PROVISIONAL
RESULTS



Locations of groundwater samples with results above detection and MCL: Nitrate

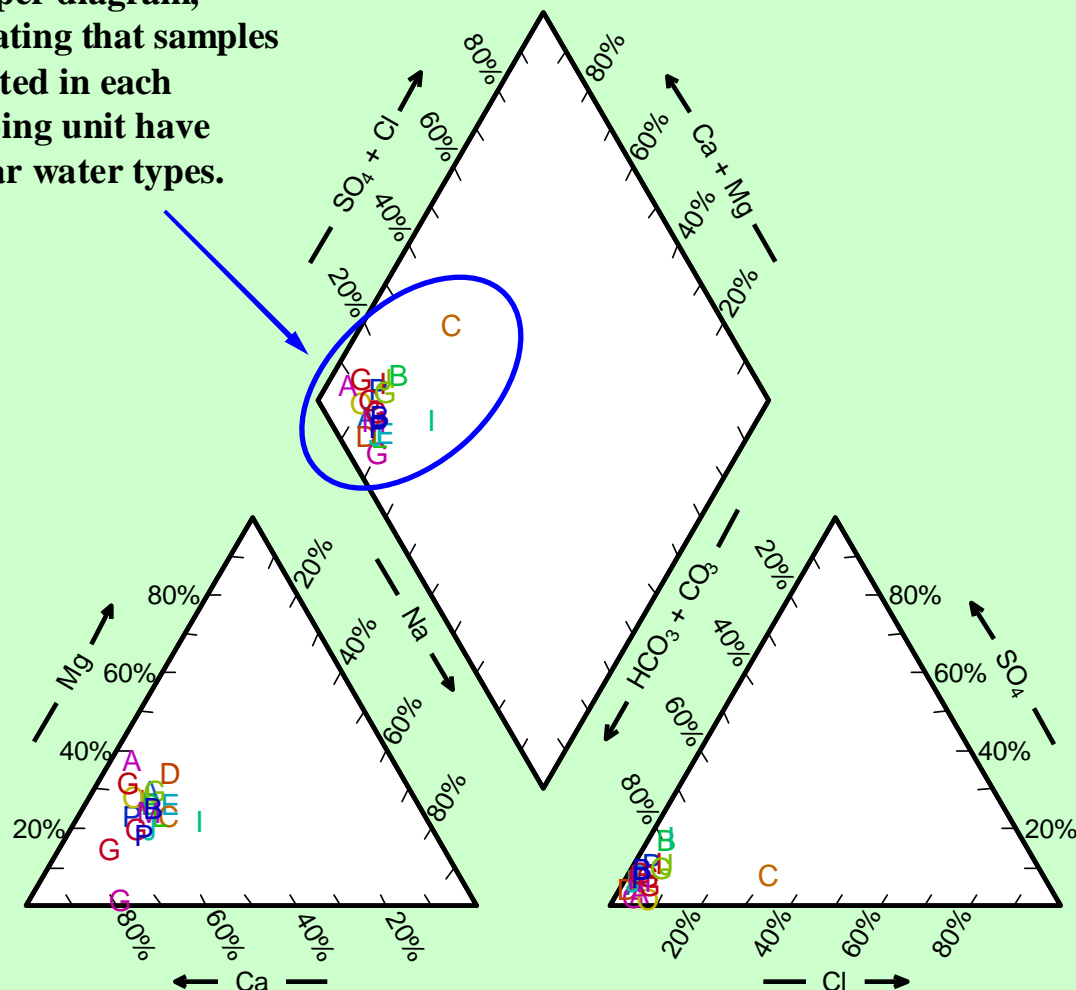


Groundwater Quality

PROVISIONAL
RESULTS

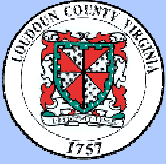
Symbols for each mapping unit plot closely on Piper diagram, indicating that samples collected in each mapping unit have similar water types.

Piper Diagram:
Median Values by Geologic Map Unit



Legend

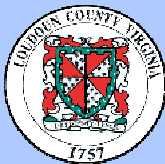
- A Swift Run
- E Zmd-Igneou...
- C Zc-Zcr-Cato...
- G Ypg-Igneous
- P Yp-Sedimen...
- I Yml-Igneous
- B Yn-Igneous
- L Jtr-Jm-Sedi...
- D Js-Jmz-Jhg...
- O JTRc-JTRcg...
- A TRbl-Sedim...
- G TRbs-TRbsh...
- G TRmp-Sedi...
- J Ybg-Igneous
- M Ygt-Igneous
- J Yhm-Igneous
- G Ylg-Igneous
- G Ymb-Igneous
- B Ymc-Igneous
- I Jd-Jdh-Igne...
- P Ca-Ch-Cw-...



On-Site Sewage Systems

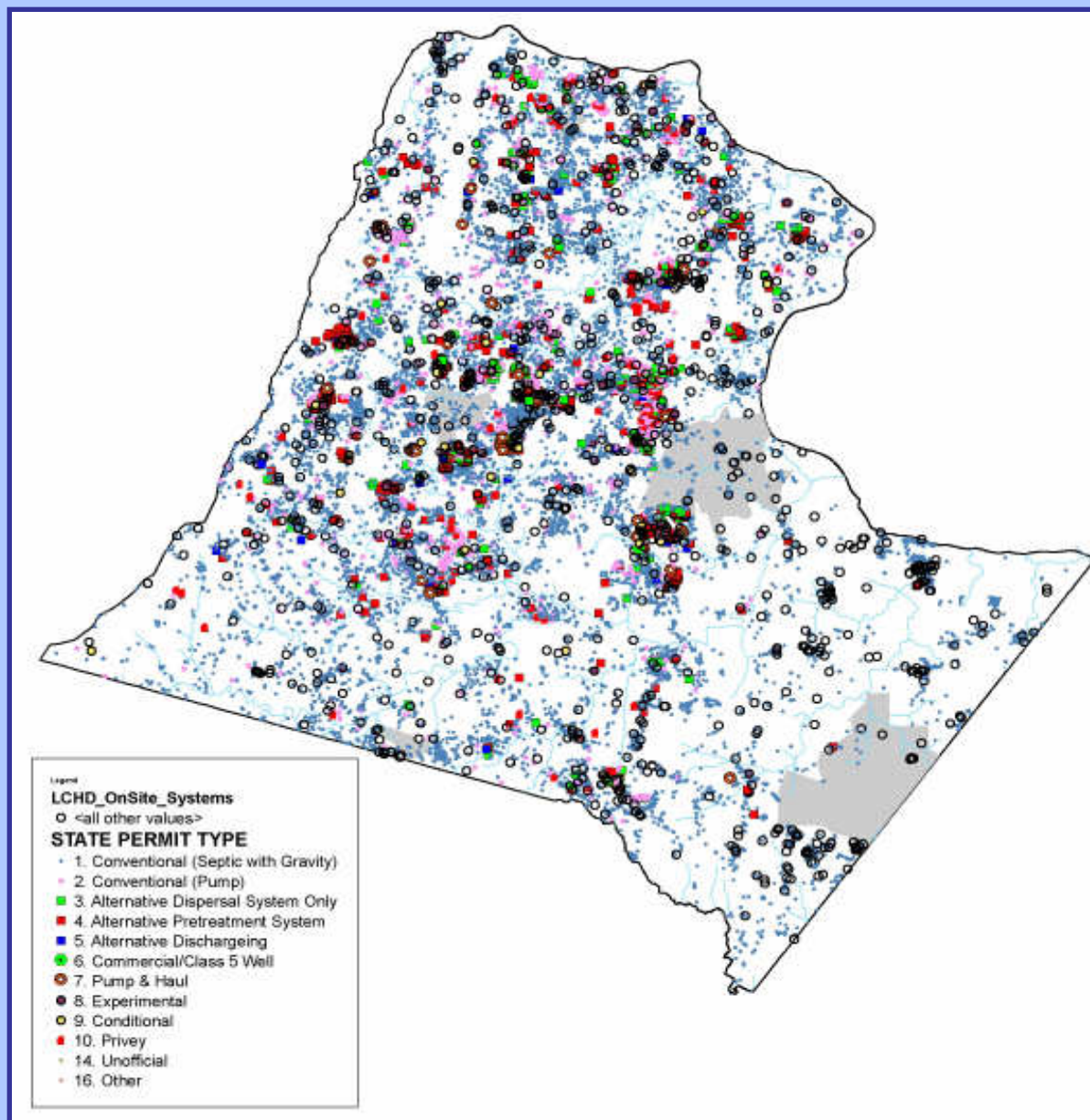
**PROVISIONAL
RESULTS**

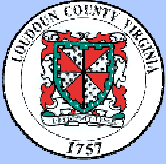
On-Site Waste Disposal Permit Types	
Permit type (VDH-defined)	Permit type description
1. Conventional (Septic with Gravity)	Septic tank with traditional gravity fed drainfield.
2. Conventional (Pump)	Traditional septic tank with above grade drainfield, pump required.
3. Alternative Dispersal System Only	Non-traditional dispersals, such as drip irrigation, mounds, peat, etc...
4. Alternative Pretreatment System	Pre-treatment units required prior to dispersal.
5. Alternative Discharging	Discharges to sewage treatment plants. Tracking numbers will be "PSTP".
6. Commercial/Class 5 Well	Systems permitted by state as Class 5 injection wells.
7. Pump & Haul	No dispersal system. Tank is pumped.
8. Experimental	Aquarobic Mounds
9. Conditional	Conditions placed on system, such as water conservation devices.
10. Privy	No dispersal.



On-Site Sewage Systems

PROVISIONAL
RESULTS

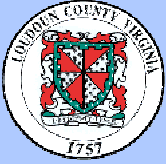




On-Site Sewage Systems

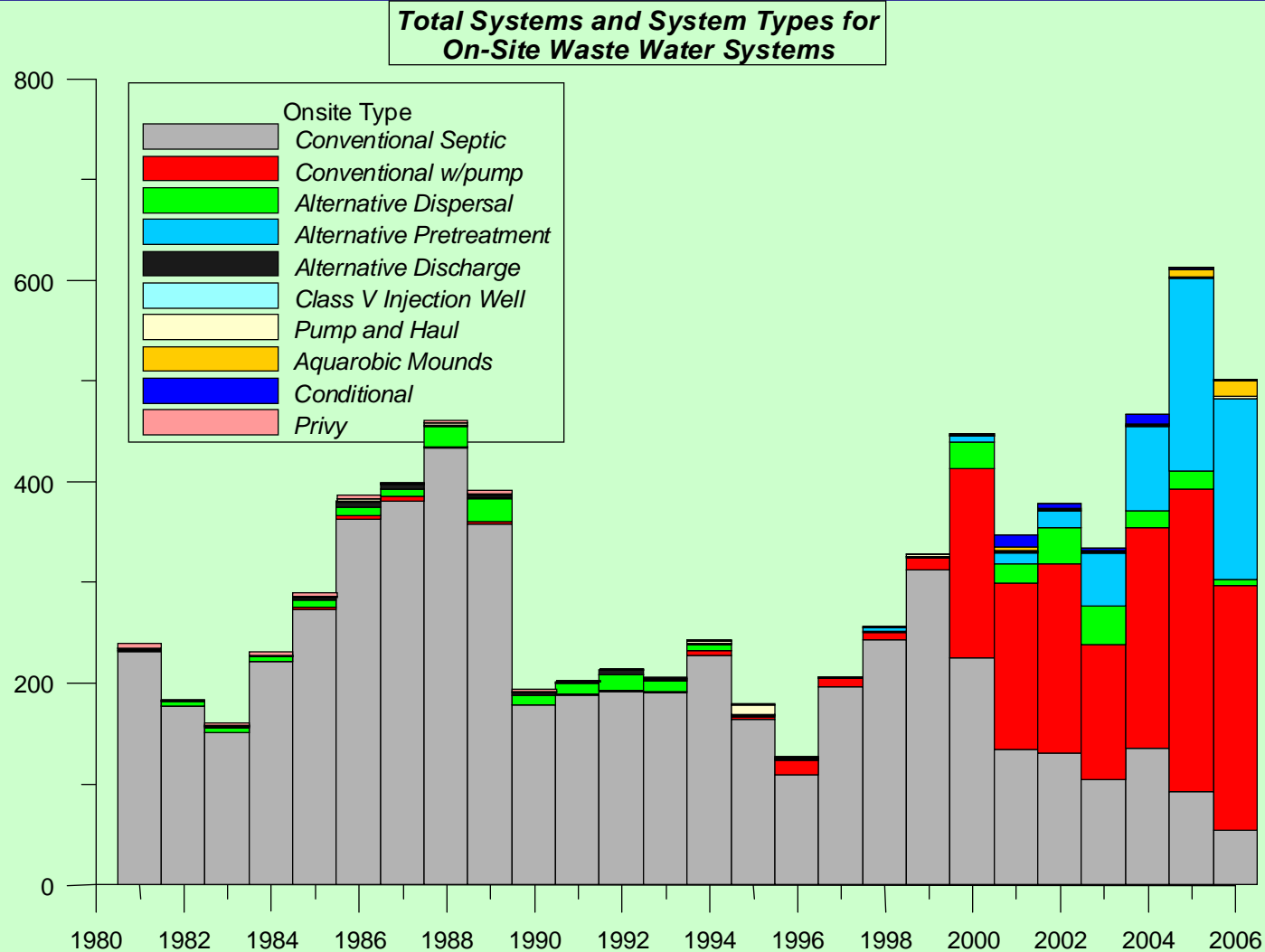
**PROVISIONAL
RESULTS**

<i>Permit Type (VDH-defined)</i>	<i>Frequency</i>
1. Conventional (Septic with Gravity)	11393
2. Conventional (Pump)	1569
3. Alternative Dispersal System Only	310
4. Alternative Pretreatment System	601
5. Alternative Discharging	37
6. Commercial/Class 5 Well	2
7. Pump & Haul	65
8. Experimental	40
9. Conditional	33
10. Privy	85

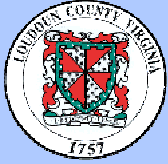


On-Site Sewage Systems

PROVISIONAL
RESULTS

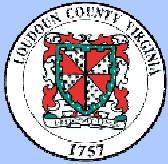


Distribution of system types prior to 1998 may not be accurate as those records have not yet been verified.
Low total system numbers in 1995-1996 due to paper records yet to be entered into digital database.



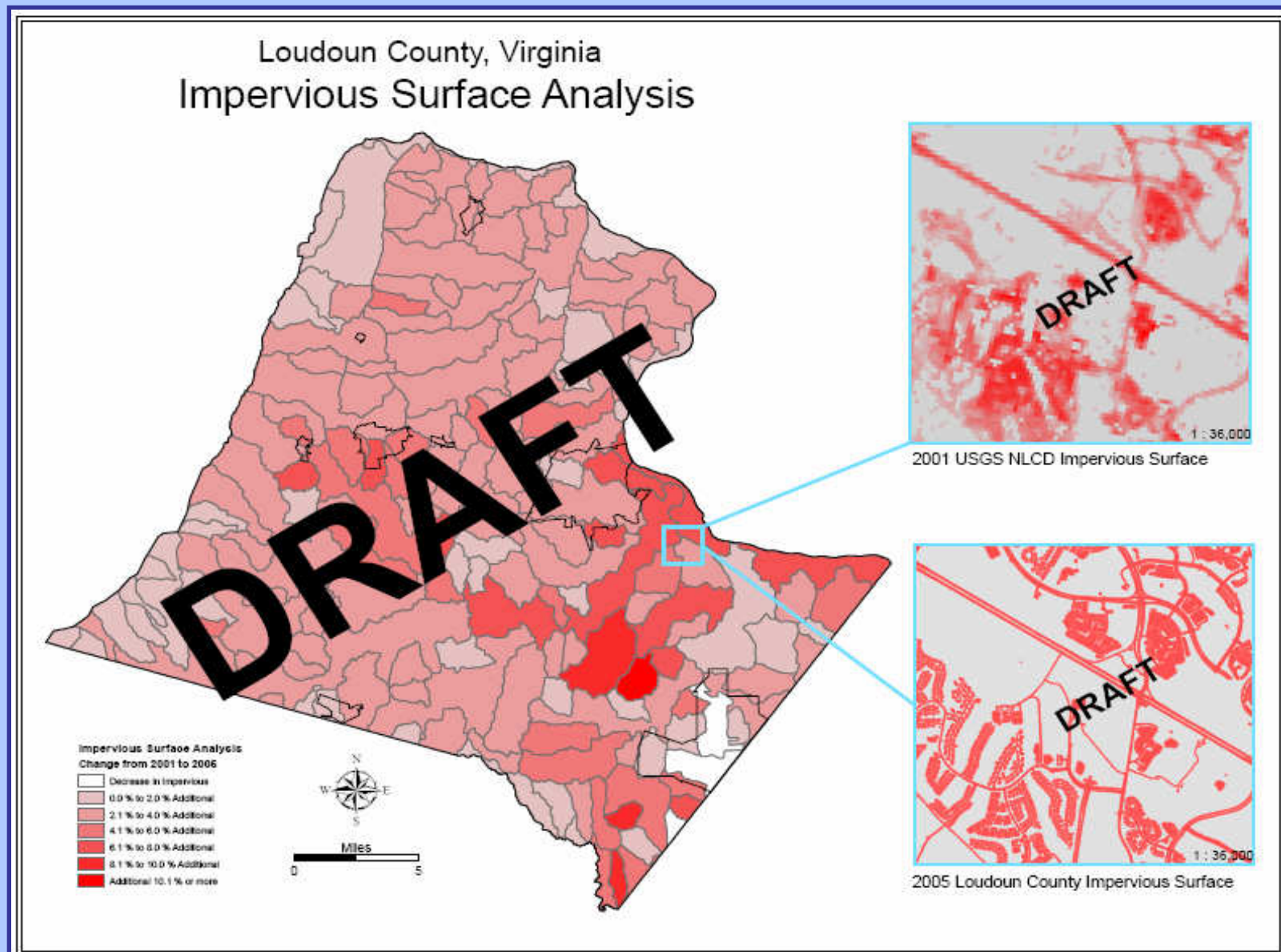
Initial Data Analyses

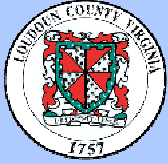
Other Preliminary Data for Assessing Water Resource Conditions



Other Data

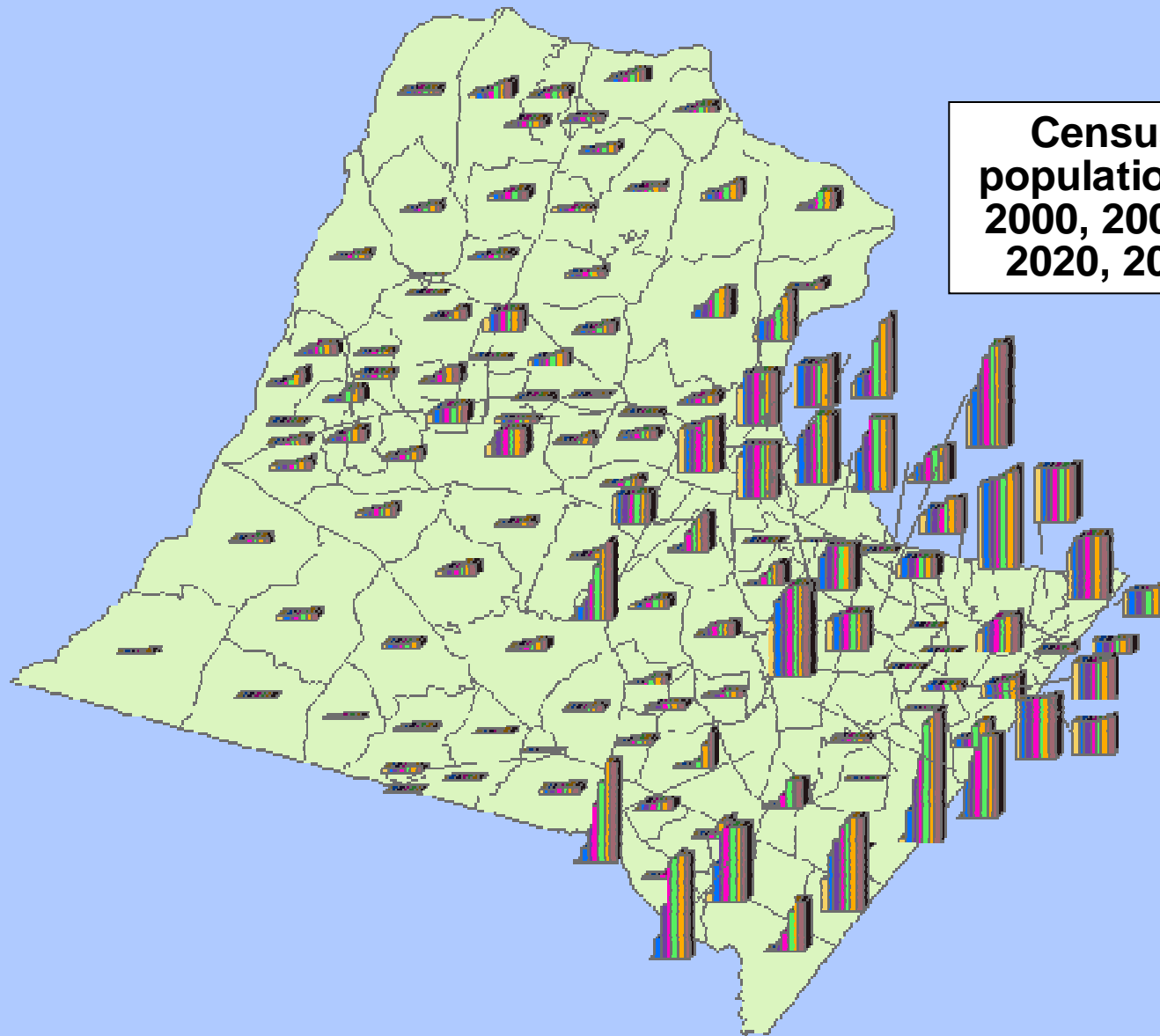
PROVISIONAL
RESULTS



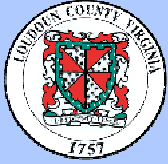


Other Data

PROVISIONAL
RESULTS



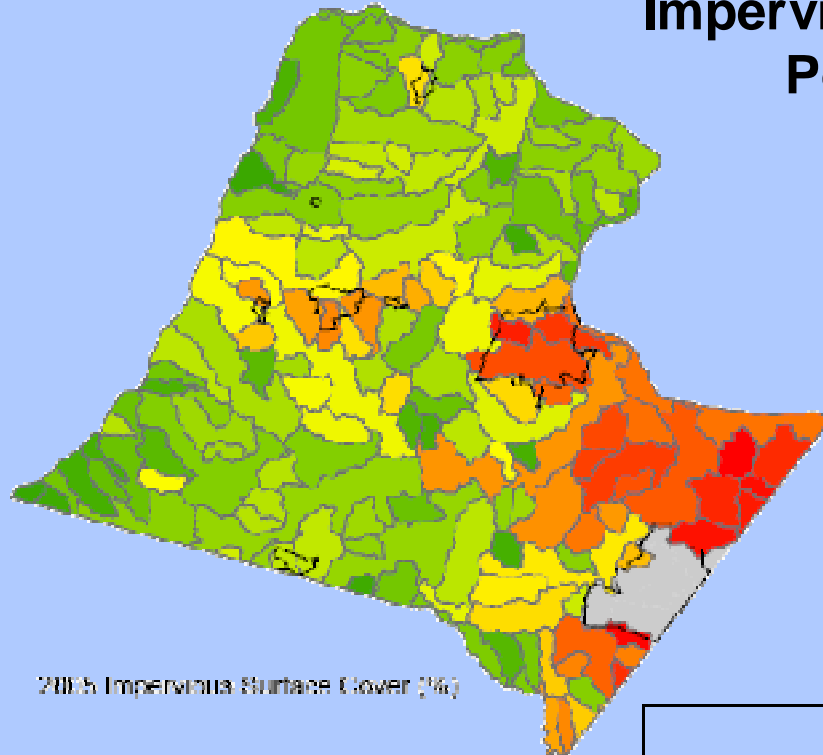
**Census count and
population projections:
2000, 2005, 2010, 2015,
2020, 2025, and 2030**



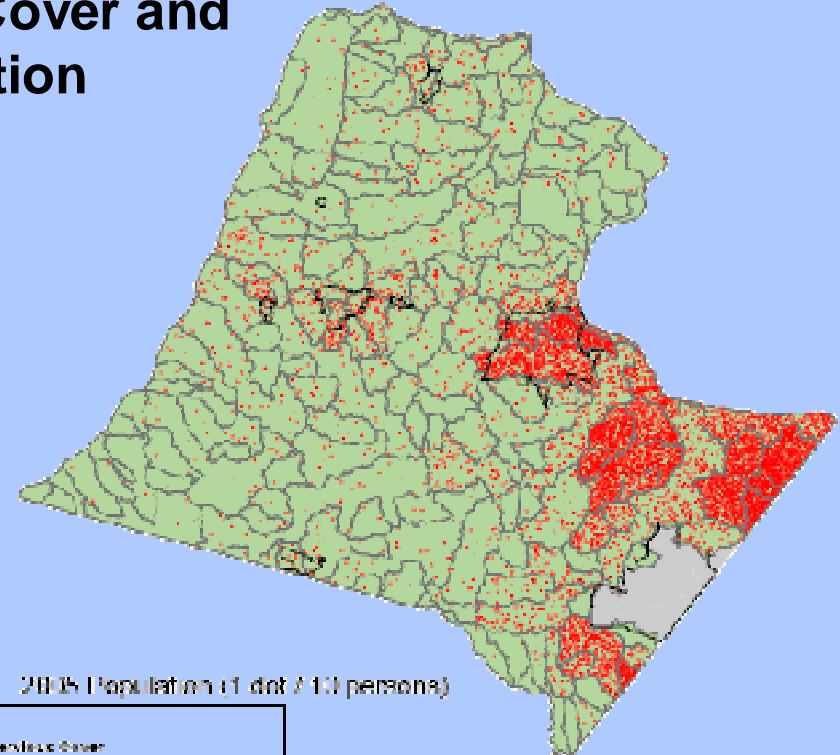
Other Data

PROVISIONAL
RESULTS

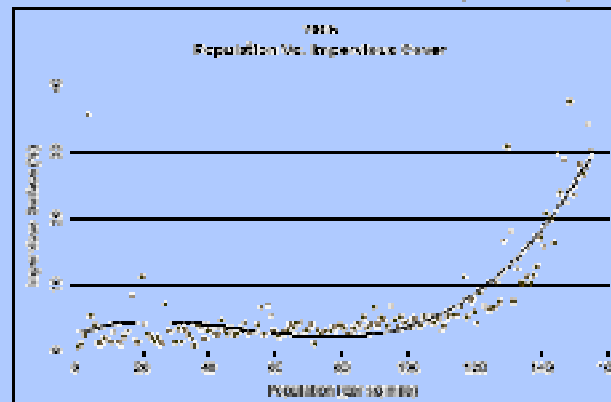
Impervious Cover and Population



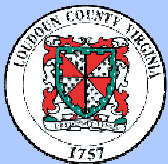
2005 Impervious Surface Cover (%)



2005 Population (1 dot = 100 persons)



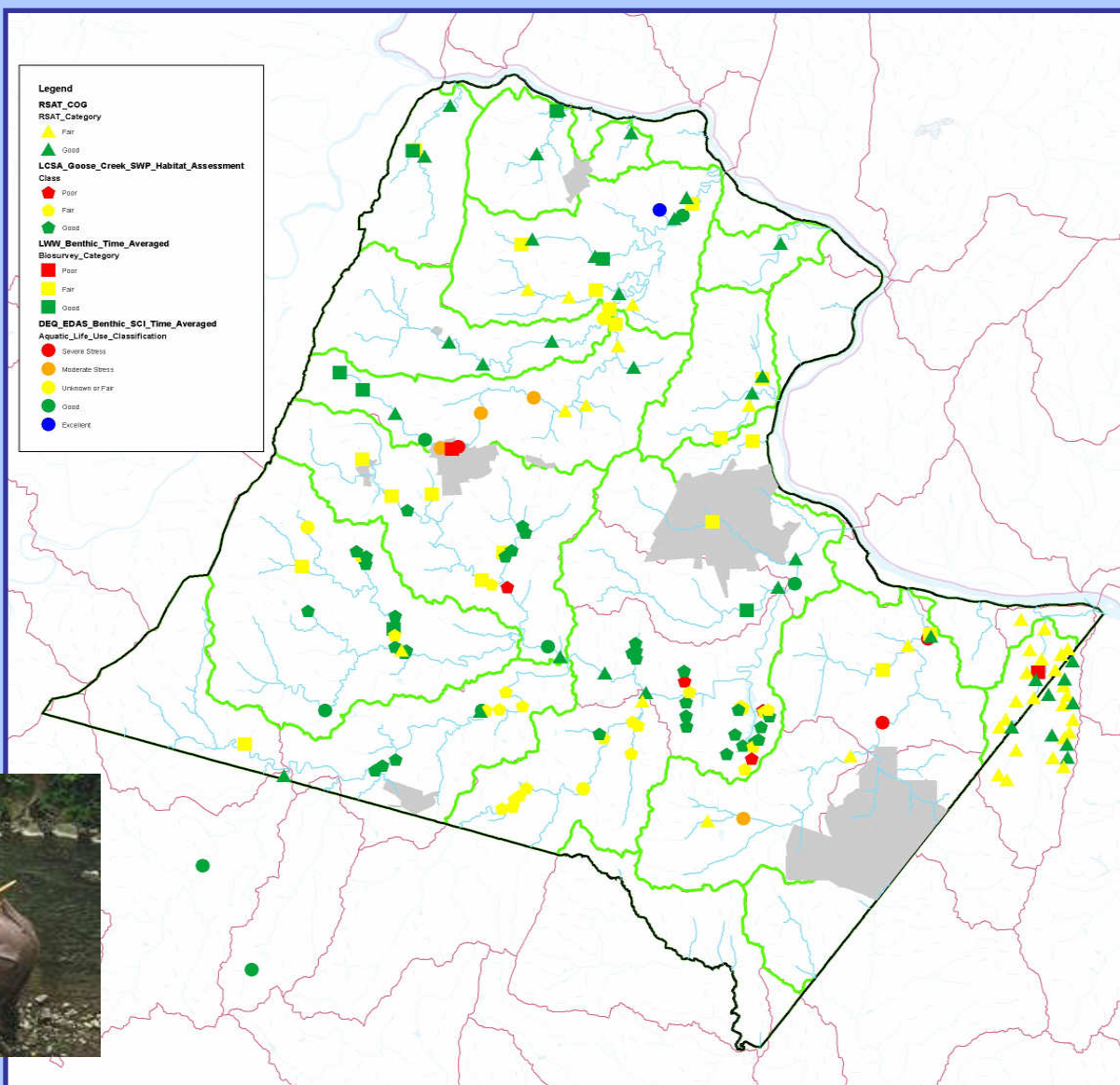
DRAFT

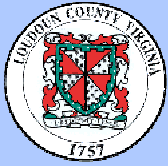


Other Data

Stream Assessment Studies

PROVISIONAL
RESULTS

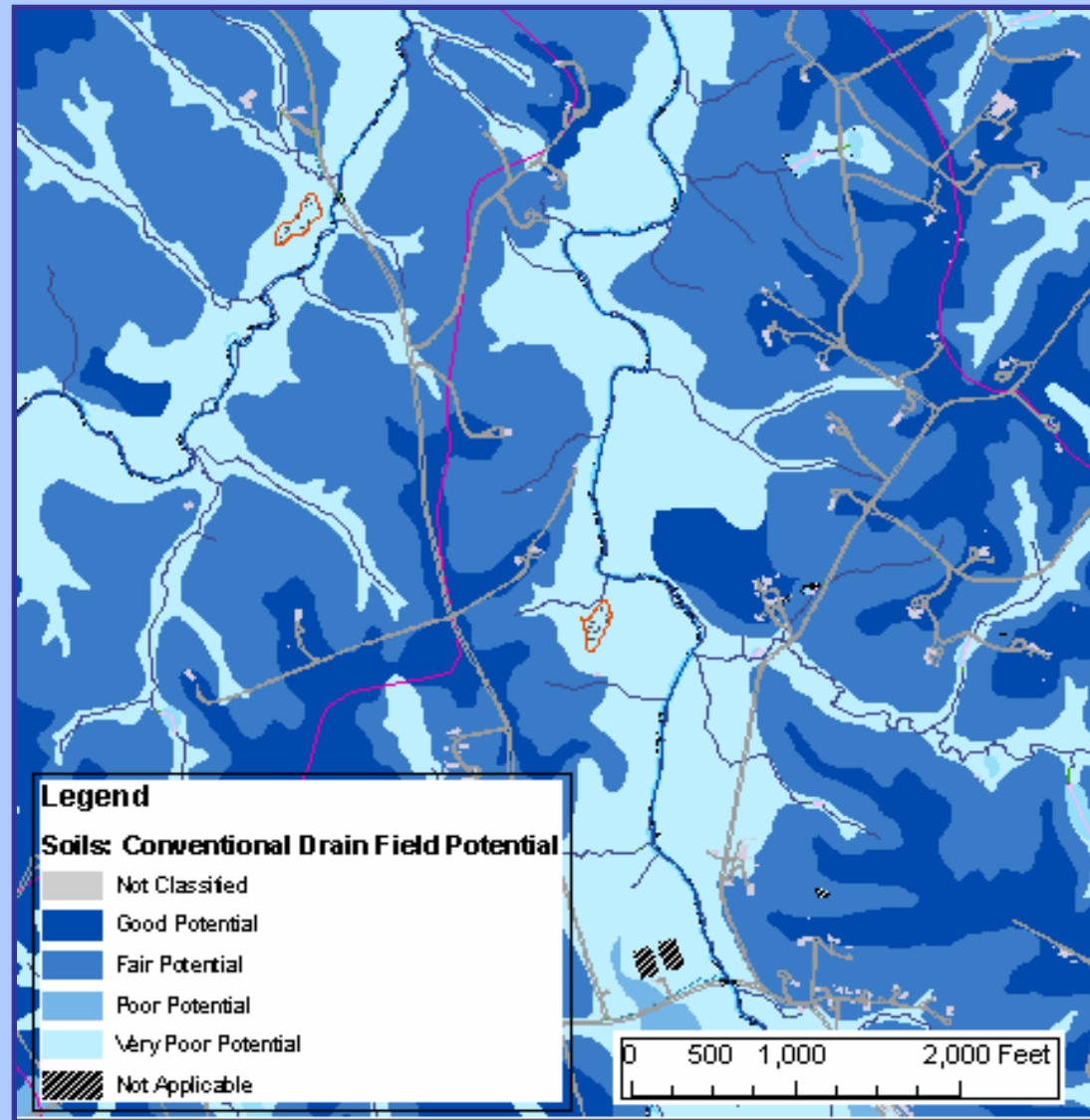


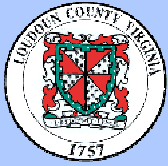


Other Data

PROVISIONAL
RESULTS

Conventional Drainfield Potential

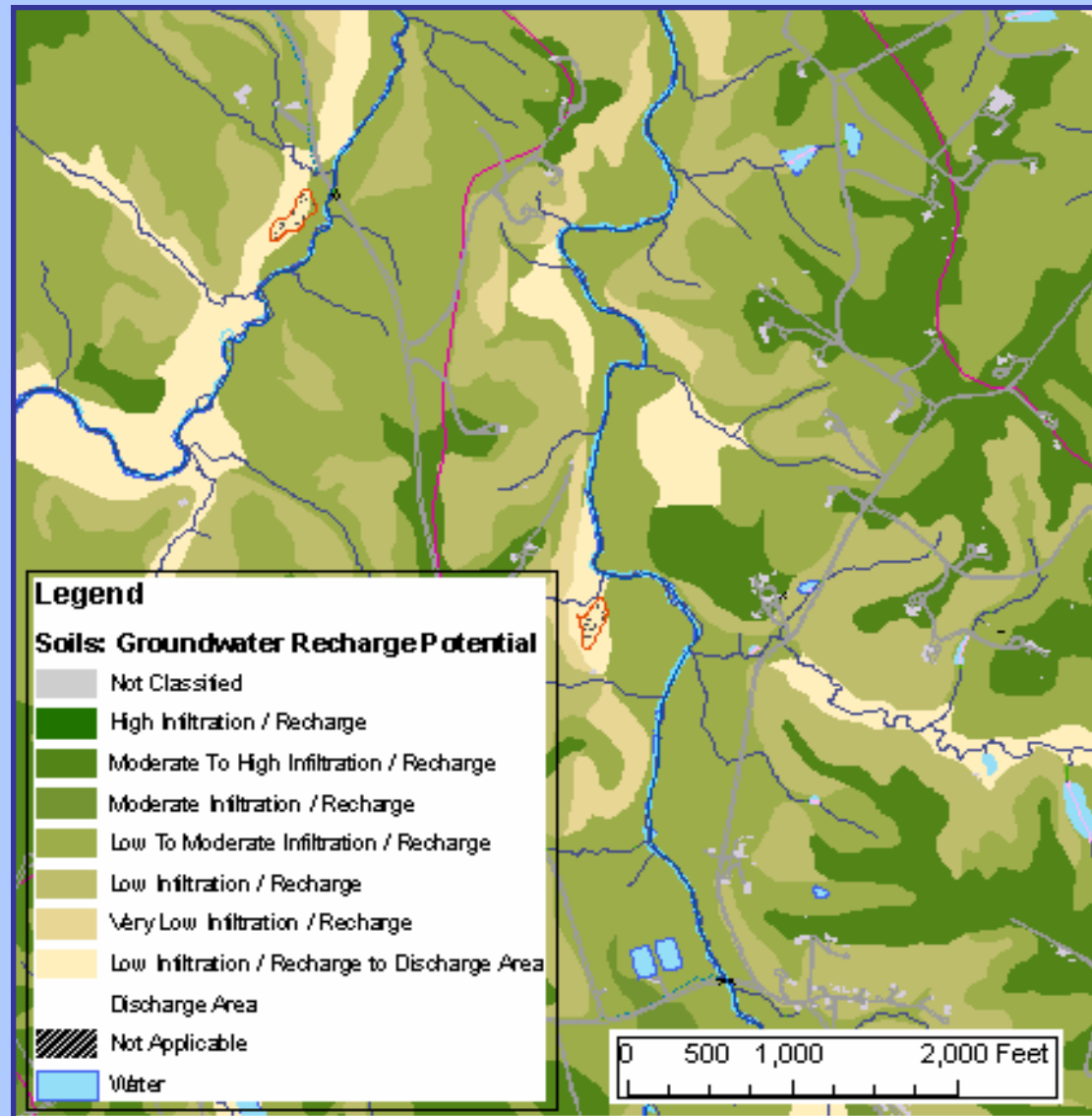




Other Data

PROVISIONAL
RESULTS

Groundwater Recharge Potential

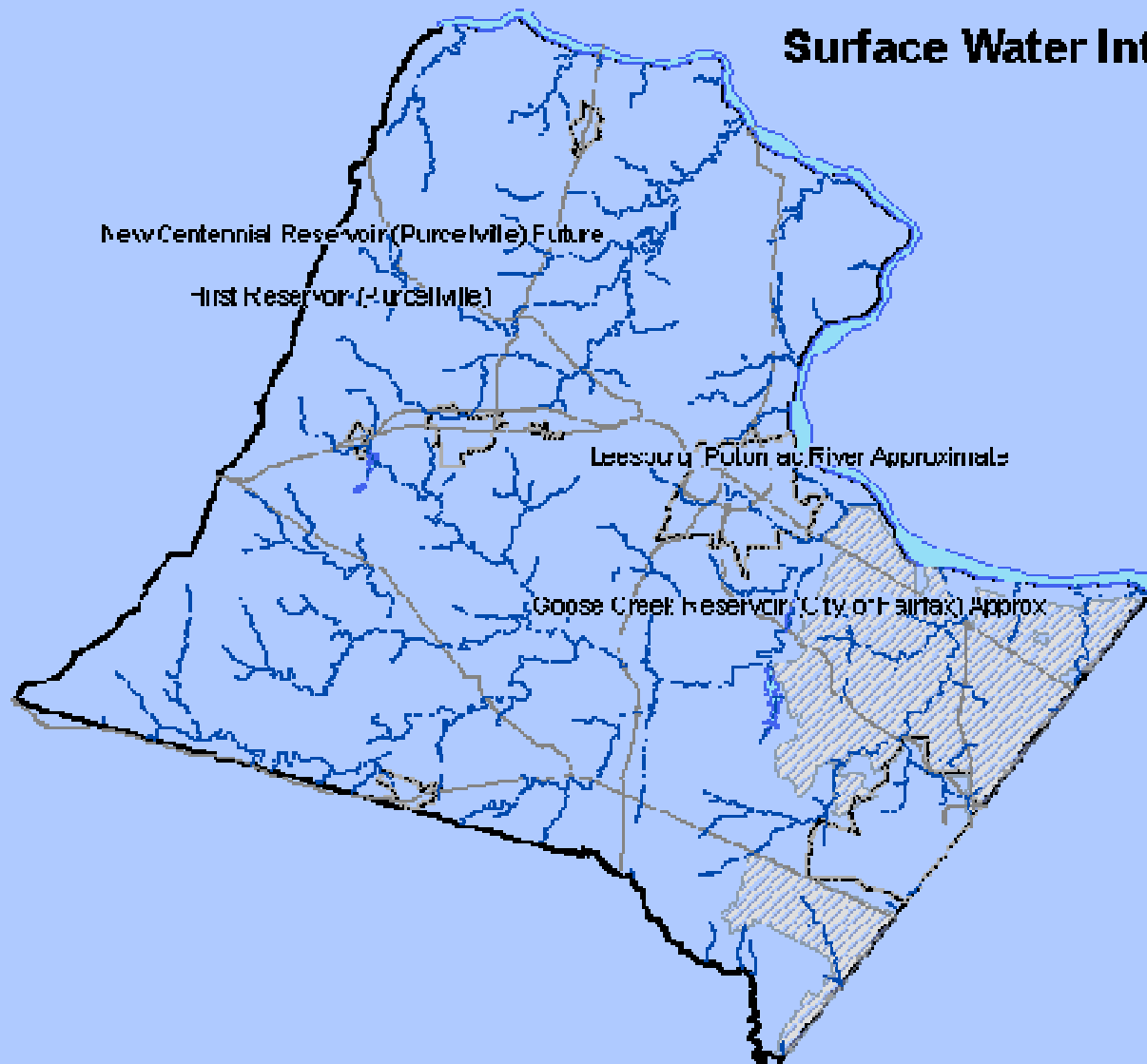


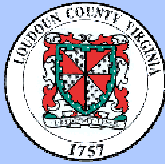


Other Data

PROVISIONAL
RESULTS

Surface Water Intakes





Other Data

**PROVISIONAL
RESULTS**

Annual Water & Wastewater Reports prepared by Draper Arden

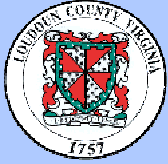
Rates in MGD were calculated from Equivalent Residential Unit values

<http://www.daa.com/news/surveys.htm>

	LCSA	Leesburg	Purcellville	Round Hill	Middleburg	Hamilton	Lovettsville	Total MGD
ERU	250	350	250	250	250	250	250	
2000	10.400	3.837	0.350	0.139	0.037	no data	no data	14.8
2001	no data	4.831	0.340	no data	no data	no data	0.049	5.2
2002	12.620	5.311	0.374	0.130	no data	0.131	no data	18.6
2003	13.277	5.487	0.373	0.172	0.206	0.130	no data	19.6
2004	13.950	5.704	0.490	0.586	0.062	0.125	no data	20.9
2005	14.237	5.639	0.598	0.293	0.660	0.125	no data	21.6
2006	15.485	5.538	no data	0.142	no data	0.150	no data	21.3

Equivalent Residential User: One equivalent residential water connection equals total water consumption per day divided by 250 gallons per day, except Leesburg is 350 gallons per day.

2007 Estimate	16.50	5.80	0.70	0.30	0.50	0.17	0.10	24.1
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Other Data

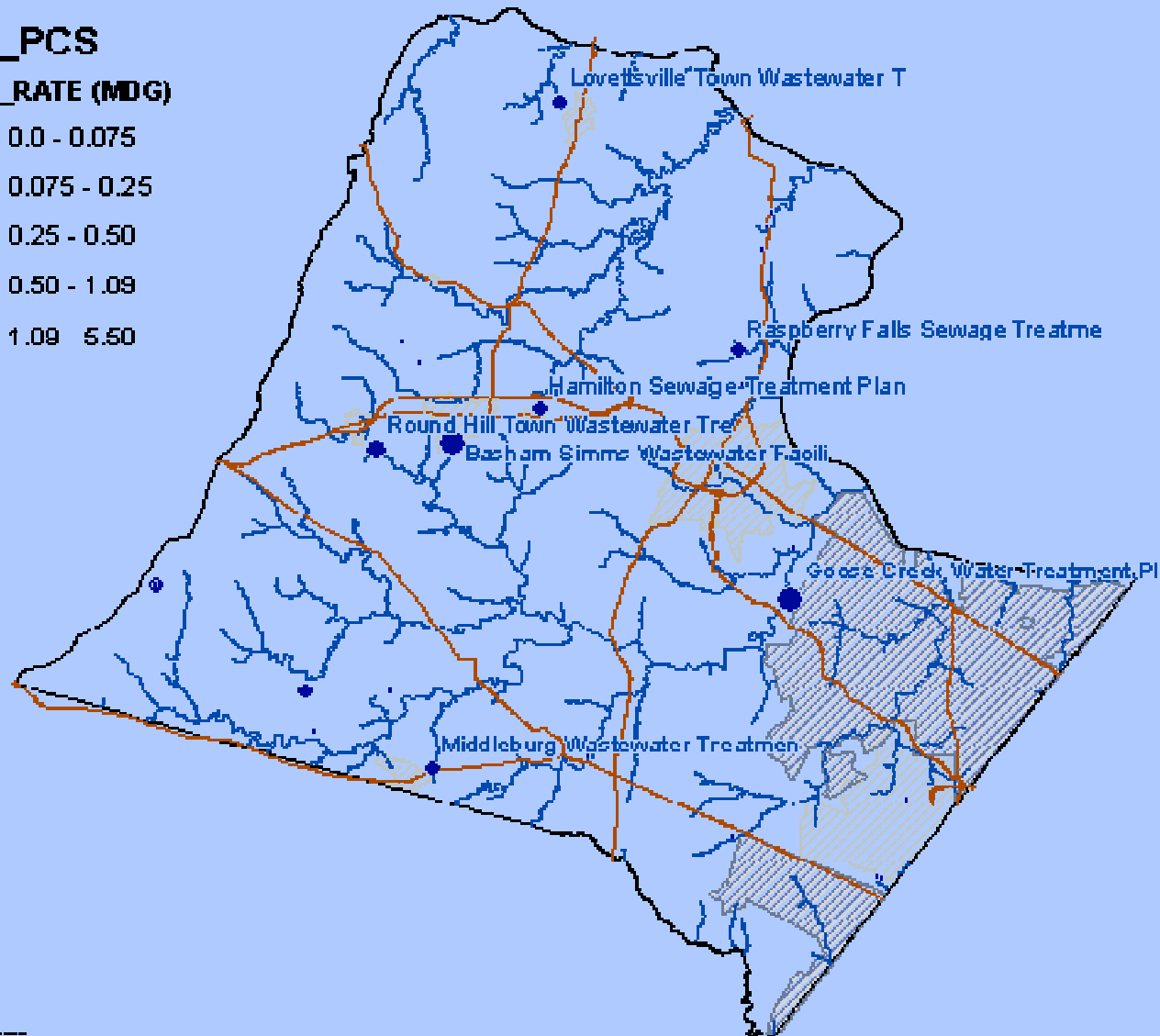
PROVISIONAL
RESULTS

Waste Water Treatment Plants

EPA_PCS

FLOW_RATE (MDG)

- 0.0 - 0.075
- 0.075 - 0.25
- 0.25 - 0.50
- 0.50 - 1.09
- 1.09 - 5.50

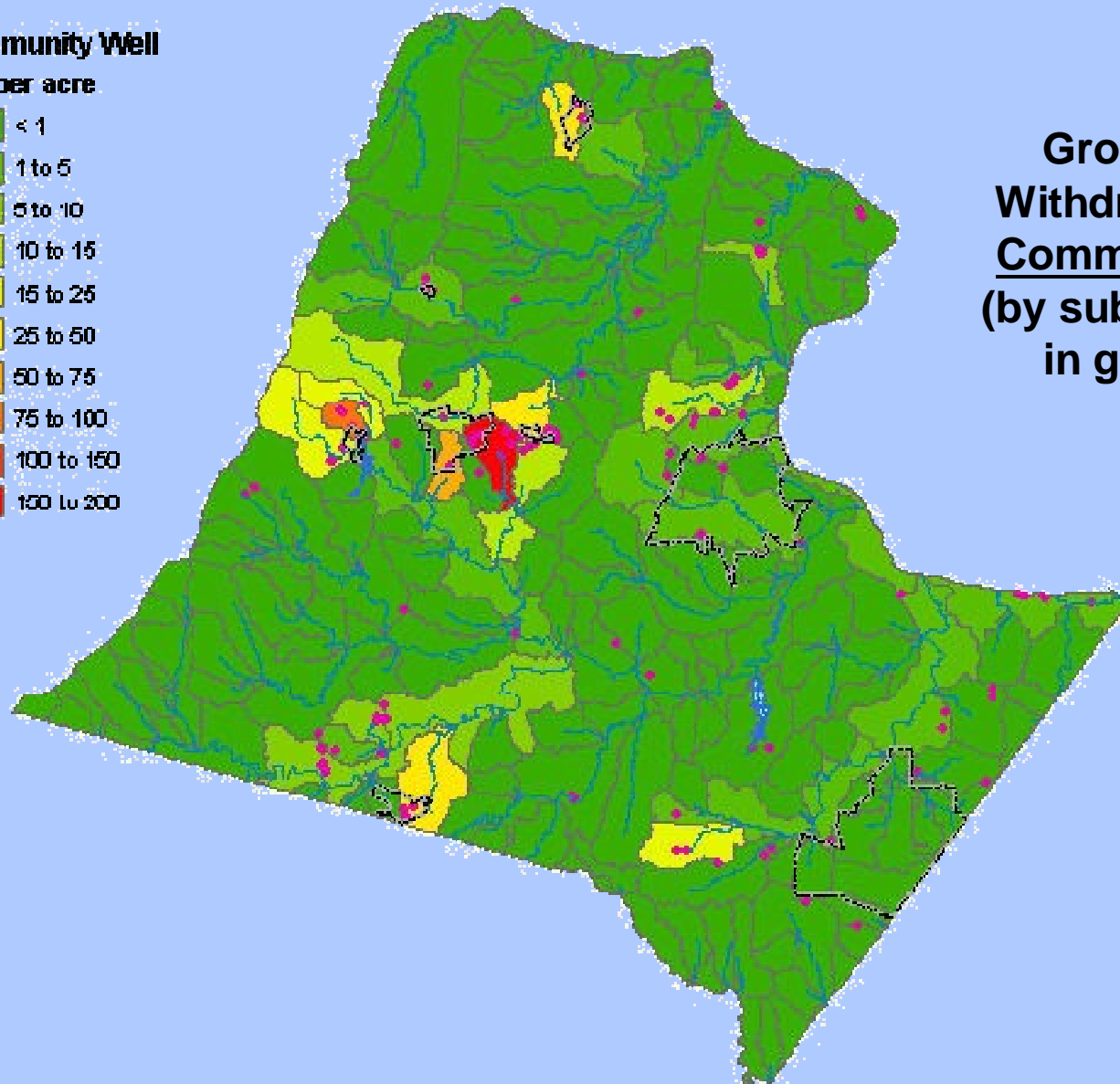




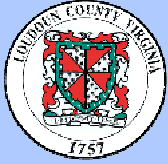
Other Data

PROVISIONAL
RESULTS

Community Well gpd per acre



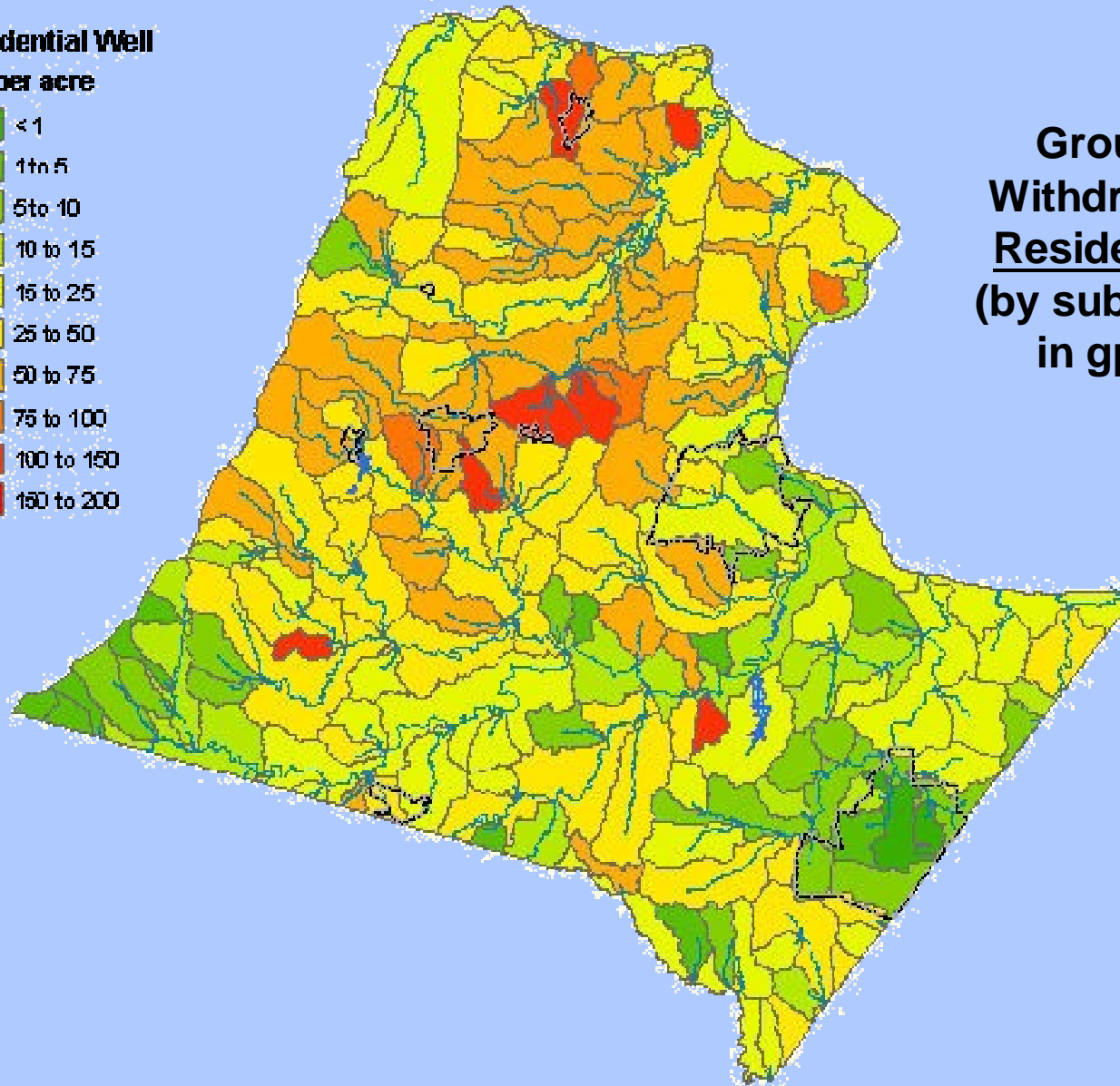
Groundwater
Withdrawals from
Community Wells
(by subwatersheds
in gpd / acre)



Other Data

PROVISIONAL
RESULTS

Residential Well gpd per acre



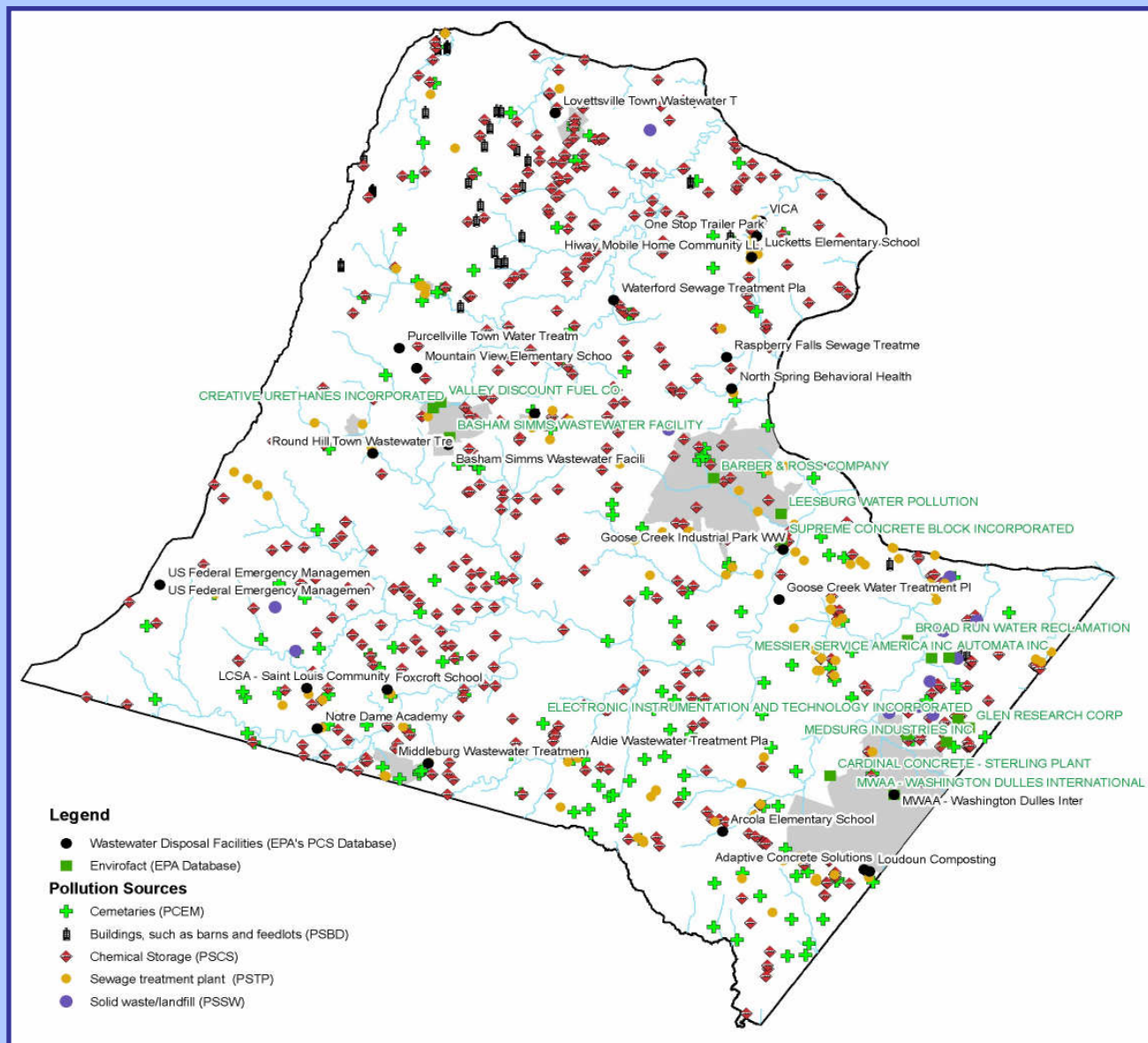
**Groundwater
Withdrawals from
Residential Wells
(by subwatersheds
in gpd / acre)**

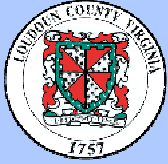


Other Data

PROVISIONAL
RESULTS

Potential Pollution Sources





*** *End* ***

PROVISIONAL
RESULTS

